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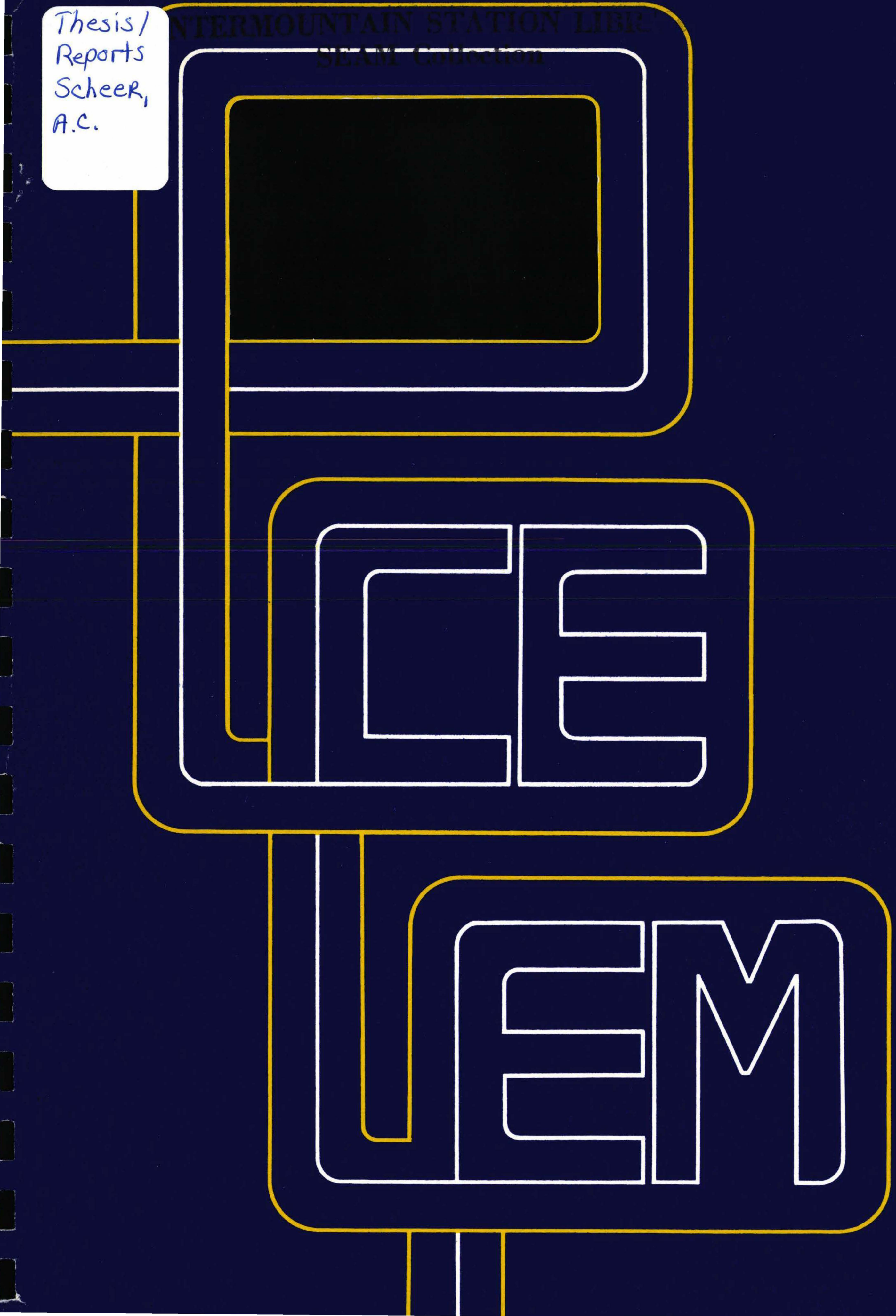

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EFFECTS OF MINE HAUL ROADS
ON THE WATER RESOURCE

A Progress Report

By

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Bozeman, Montana 59717

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SURFACE ENVIRONMENT & MINING
SEAM
USDA FOREST SERVICE PROGRAM

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INTRODUCTION

The impacts of road construction and operation on the water resource have long been recognized. As a result, various methods and treatments have been implemented to minimize degradation of the water resource due to roads (i.e., slope treatments, sediment traps). However, a universally accepted method of quantitatively predicting the impacts of roads has not yet evolved. Sedimentation, being the primary 'culprit', has received the most attention; and some success in prediction model development has been attained.

Haul road systems for surface mining are no exception and may contribute more degradation to water resources than conventional roads. Recognizing this, SEAM (Surface Environment and Mining) under the U.S. Department of Agriculture, Forest Service, initiated studies aimed at identifying and quantifying water degradation parameters resulting from haul roads. Studies were initiated in 1974, which attempted to broadly view environmental impacts and transportation systems. The scope was reduced to a more workable focus, haul roads and water resource, in June 1975. In June 1976, an Interim Report (1) was published by the Civil Engineering and Engineering Mechanics Department of Montana State University. The Report summarized results of a large-scale literature review and an information search on subject material related to roads and water degradation. As one would expect, information on sedimentation was the most abundant; and the Report centered on the adaptation of the Universal Soil Loss Equation, a method of predicting annual sediment amounts from agricultural lands.

This report will summarize the progress of the MSU Civil Engineering group during the past year, ending date July 1, 1977. It is written in partial fulfillment of research agreement, Supplement No. 45 to 12-11-204-12, under U.S. Forest Service Research Work Unit FS-INT-1652. Entitled Study EPA, 77BED-Task II-Effects of Mine Haul Roads on the Water Resource, the study work schedule states the following phases related to this report:

July 1, 1976 to Sept. 30, 1976 - continue collection of information on road effects; continue development of mathematical relationships; begin the assembly of a mathematical model.

Oct. 1, 1976 to Sept. 30, 1977 - complete collection of information on road effects; complete development of mathematical relationships; continue assembly of a mathematical model; begin refinement, calibration and testing of the mathematical model; begin documentation and preparation of reports.

The content of this progress report is divided into two parts, hydrological modeling and water quality discussions. Under hydrological modeling, are included preliminary reviews of two process models that have been introduced during the past year. Basically, both models deal primarily with water and sediment yields. These reviews are followed by brief discussions on the status of study of snowmelt effects upon sedimentation, and then with status comments on potential field sources of data needs for the model testing. Under the heading of water quality are included a state of the art summation and the future outlook in terms of modeling and data source potential.

The crux of this report is that there does appear to be hope for modeling the quantitative impacts of surface mining haul roads on the water resource. However, the hope is keyed to the availability of representative and applicable data. As outlined in the body of this report, these data sources are not readily available at the present time.

HYDROLOGICAL MODELING

There are basically two types of hydrologic simulation models. They are known as deterministic and stochastic models. Deterministic models express hydrologic processes using variables without regard to the probability of occurrence of these variables. Stochastic models formulate hydrologic processes considering the probability of occurrence of the variables. It is obvious from these definitions that a stochastic model would require a reliable long-term data base in order to project future events. A stochastic model is the Universal Soil Loss Equation (USLE) which was discussed in the Interim Report (1).

Due to the lack of sufficient data on the hydrologic effects of haul roads, a physical process or deterministic model is believed to be more appropriate to define the hydrologic aspects of haul roads in existing and proposed mine areas. Simons, Li, and Shiao (2) have developed a physical process type of road sediment model (Appendix II). The Colorado State University (CSU) Road Sediment Model has resulted from research on timber haul roads conducted by the U.S. Forest Service. The model is untested, but due to its structure, it lends itself to a cooperative program of evaluation and testing. Meetings with Simons, Li, and representatives of the U.S. Forest Service have led to such a program. A review of the model and results of preliminary testing will follow.

Also included in this section of the report is a brief discussion of a regression equation model developed by Younkin of Bucknell University. An introduction into snowmelt effect on sedimentation and the status of pertinent California and other field studies will conclude this section.

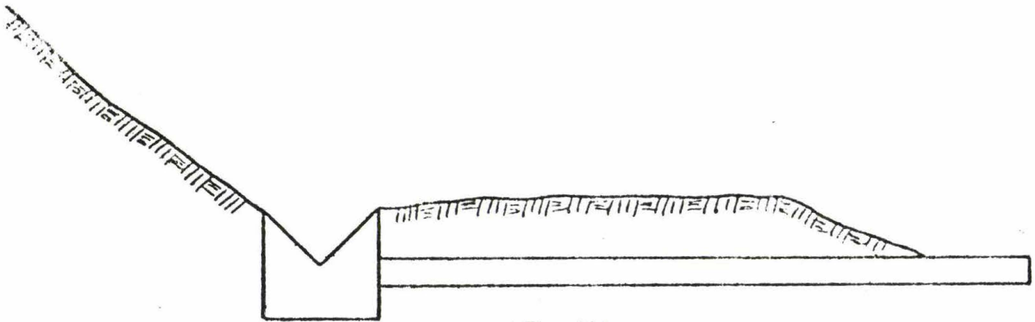
The CSU Road Sediment Model

It should be pointed out that this portion of the report is a summary of the draft users guide "Formulation of the Road Sediment Model" by Simons, Li, and Shiao (2) and as a result it draws heavily on the authors' text. This summary is necessary in order to give an accurate description of the operation and mechanics of the CSU Road Sediment Model (ROSED).

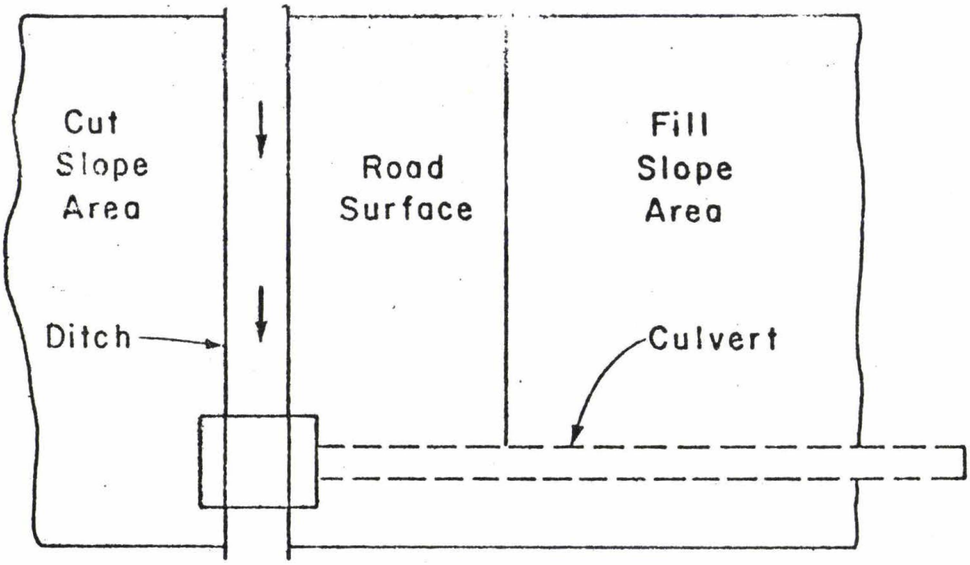
The model is formulated according to the physical principals of water flow and soil erosion processes. A typical road prism is considered to be composed of five individual but interconnected response units (Figure 1). Each of these response units is assumed to be uniform with respect to its physical characteristics. The model predicts water and sediment yields for 1 ft segments of the overland flow units and total flows for the specified source areas for ditches and culverts. Variations in prism geometry require addition of more response units to the input data with the appropriate specifications.

The model was developed to predict sediment yield from surface runoff events on forest roads. The model uses mathematical formulations of known physical processes to predict the sediment yield for individual events. The format also lends itself to the prediction of water and sediment yields from mine haul roads and other types of transportation corridors. At the present time, this model is untested due to the lack of field data. However, it still has utility as a tool for assessing the potential erosion effects of different road locations and variations in road prism geometry or changes in design criteria.

The Road Sediment Model makes a water and sediment yield prediction for individual runoff events. The model uses the Green-Ampt (3) infiltration



Profile


Cut
Slope
Area
Road
Surface
Fill
Slope
Area
Ditch
Culvert

Plan

Figure 1. Typical road prism. (from Simons et al.)

equation, a surface storage factor, canopy interception, and antecedent soil water content--to determine if there is a rainfall excess. Once these storage capacities have been satisfied, the rainfall excess is routed as surface runoff. Water routing is achieved with the equation of continuity, the momentum equation, and the equations which describe channel geometry and flow resistance. Water and sediment routing is done in discrete time increments set by the user for the duration of the event and a 1/2 minute interval is usually selected.

Water Routing Equations

The Darcy-Weisbach friction factor (f') is used in the kinematic wave approximation of the momentum equation in the following manner:

$$S_o \simeq S_f = f' \frac{Q^2}{8gRA^2}$$

where:

S_o = channel bed slope

S_f = water surface slope

f' = Darcy-Weisbach friction factor

Q = discharge in ft^3/sec

g = acceleration of gravity in ft/sec^2

R = hydraulic radius of channel in ft

A = cross sectional area of channel in ft^2

The hydraulic radius is defined as:

$$R = \frac{A}{P}$$

P = wetted perimeter of the channel in ft

The wetted perimeter is defined as:

$$P = a_1 A^{b_1}$$

where: a_1 and b_1 are constants which vary with the shape of cross-sectional area.

In overland flow condition a_1 and b_1 are 1.0 and 0.0, respectively.

The overall Darcy-Weisbach friction factor (f') is defined as:

$$f' = \frac{K_g}{N_r}$$

where: K_g = constant describing overall resistance

N_r = flow Reynold's number

The flow Reynold's number is determined in the relation:

$$N_r = \frac{QR}{\nu A}$$

where: ν = kinematic viscosity

The overall resistance K_g is determined for the flow situation in the following manner:

$$K_g = K_\ell + (K_h - K_\ell)\, C_g^2$$

where: K_ℓ = least resistance

K_h = maximum resistance

C_g = ground cover density (range = 0. to 1.)

The values of K_ℓ and K_h are empirical

Sediment Transport Equations

The CSU Road Sediment Model uses the Meyer-Peter-Muller bed load transport equation where:

$$q_b = \frac{12.85}{\sqrt{\rho}\ \gamma_s} (\tau_o - \tau_c)^{1.5}$$

q_b = bed load transport rate in volume per unit width for a specific size sediment

ρ = mass density of water (1.936 $\frac{\text{lb sec}^2}{\text{ft}^4}$) @ 70°F

γ_s = specific weight of sediment (165.095 lb/ft^3)

τ_o = boundary shear stress acting on the grain

τ_c = critical shear stress

At a given temperature, the quantity:

$$\frac{12.85}{\sqrt{\rho}\ \gamma_s}$$

can be assumed constant. Then the critical shear stress can be determined from the relation:

$$\tau_c = \delta_s(\gamma_s - \gamma)d_s$$

where: δ_s is constant dependant on flow conditions (assume 0.047 unless rilling develops, then lower)

d_s is the sediment size being considered

γ is specific weight of water

Shear stress (τ_o) is calculated as follows:

$$\tau_o = \frac{1}{8}\rho f V^2 = \frac{1}{8}\rho \frac{K_o}{N_r} V^2$$

$$V = \frac{Q}{A}$$

where: f is the Darcy-Weisbach friction factor due to grain resistance

K_o is a constant for the grain resistance

In the CSU model, Einstein's logarithmic velocity profile is assumed where:

$$\frac{\mu_\xi}{U_*} = B + 2.5 \ln \frac{\xi}{n_s}$$

where: μ_ξ equals the point mean velocity at the distance ξ from the bed

U_* is shear velocity of the flow

and B = constant dependent on roughness

n_s = the roughness height

Einstein (1950) used the following equation to relate bedload transport rate to suspended sediment:

$$q_b = 11.6\ C_a\ U_*\ a$$

where: C_a = sediment concentration near the bed layer

a = thickness of the bed layer which is twice the size of sediment

By substitution, the suspended sediment load is determined in the following formula:

$$q_s = (q_b/11.6)\ \frac{G^{w-1}}{(1-G)^w}\ \left(\left(\frac{V}{U_*} + 2.5\right) J_1 + 2.5\ J_2\right)$$

G = sediment transport capacity

w = segment width

J_1 & J_2 = integrals derived by Li (4)

Therefore, the total sediment transport rate per unit width of channel is:

$$q_t = q_b + q_s$$

Sediment Supply

Sediment supply is dependent on the initial depth of loose soil left from previous storms, the amount of soil detachment by raindrop impact, and the amount of soil detachment by flow. On interrill sites, the physical process of soil particle detachment from the soil mass is primarily caused by raindrop impact and splash on the soil surface. Laboratory measurements of particle detachment by splash have been made by a number of researchers.

Young and Wiersma (5) found in their tests that soil detachment can primarily be attributed to raindrop splash. However, transport of detached particles was primarily accomplished by rill flow. Farmer (6) determined that particle detachability was not significantly affected by slope steepness up to a 30% slope. As slope steepens, however, the net downslope **movement** by splash is increased (7).

The amount of soil detachment is directly related to the raindrop energy and the soil erodibility. The CSU model assumes a potential rate of soil detachment in units of depth per unit time from the formula described in Meyer (8).

$$D_r = a_2 \, i^{b_2} \left(1 - \frac{Z_w}{Z_m}\right) (1 - C_g) (1 - C_c)$$

where: i = the rainfall intensity (in/hr)

a_2 = parameter dependent on soil characteristics

b_2 = constant (2.0 from Meyer)

Z_w = depth of water plus loose soil depth

Z_m = maximum penetration depth of raindrop splash

C_g, C_c = coefficients for the amount of ground cover and canopy cover, respectively

If no surface runoff occurs during a precipitation event, then the soil detached by raindrop impact is accumulated on the soil surface. This accumulation process will continue until an event occurs which causes surface runoff. If this event is not large enough to flush the accumulated detached soil, then the raindrop detachment will not become significant until the detached soil begins to wash off the interrill areas. As detachment continues, the soil surface will begin armoring with the larger particles which are more resistant to splash detachment. Throughout a precipitation event, the model adjusts the D_{84} (the size of sediment for which 84% of the sample is finer) in each particle size class to account for the armoring effect.

The determination of the amount of soil detachment by surface runoff is made by comparing the total sediment transport capacity of the flow with the total amount of loose soil in each particle size class. If the loose soil storage on the surface is greater than the transport capacity of the flow, then no detachment by the flow occurs. If, however, the flow transport capacity exceeds the loose soil storage, then detachment by the flow is determined by the formula:

$$D = -D_f(\Delta Z^p + Z)$$

where D is the total amount of detached soil, D_f is the flow detachment coefficient (values range from 0.0 to 1.0), ΔZ^p is the total potential change in loose soil storage, and Z is the loose soil storage. This accounting procedure is done in discrete time increments (usually 1/2 minute) for the entire duration of runoff for the event.

A Preliminary Test of the CSU Road Sediment Model

Preliminary testing of the CSU Road Sediment Model for potential applicability in the SEAM Mine Planning System was begun at Montana State University in June 1977. Since no mine haul road data is presently available, a test data set was compiled from an erosion study conducted on mine spoil in North

Dakota (9). These erosion tests were conducted using a Purdue type rainfall simulator on mine spoil material. Standard (72.6' long x 13.3' wide) erosion plots were used for the measurement of runoff and erosion from the rainfall simulator.

Gilley et al. had a series of 10 plots located on spoils with 4 slope gradients. Two of these plots had a surface dressing of topsoil material with thicknesses of approximately one and two feet. The other eight bare spoil plots were grouped in 4 pairs in which each pair had the same slope. In each of these replications, one plot was cultivated and the other was left in an undisturbed condition.

A cultivated bare spoil plot with 10% slope was selected for initial testing of the CSU Road Sediment Model. A cultivated plot was selected because of its similarity to a newly completed road cut which has not been rilled and armored by previous runoff events. A soil particle analysis was made on spoil material obtained from a site adjacent to the cultivated plot. This analysis was made to make the input data more compatible with the input requirements of the sediment routing portion of the Road Sediment Model. Wet sieving was used to determine particle diameters larger than 0.074 mm; and the hydrometer analysis was used for particle sizes below 0.074 mm in size. Results of the analysis are given in Figure 2 and Table 1.

The gradation stemming from the particle analysis resulted in a different soil classification for the sample material than that given by Gilley for the erosion plot. The sample textural classification was a clay while the erosion plot had a clay loam texture. This difference in

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SOIL MECHANICS LABORATORY

GRADATION CURVE

BY ________ LABORATORY NO ________
DATE July 29, '77 FIELD NO Gilley Sample

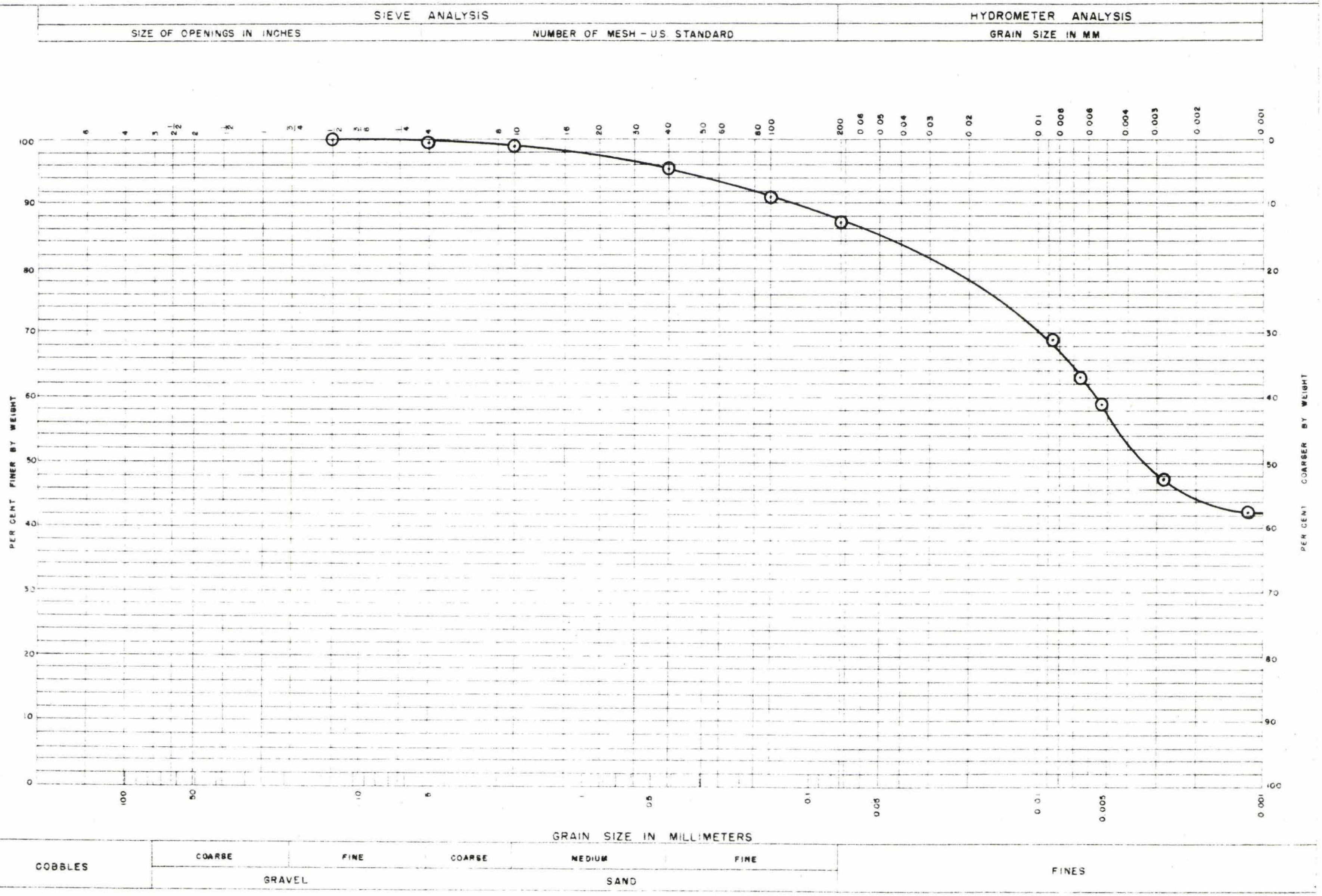

FIG. 2

Table 1. Particle Size Distribution

Geometric Mean (mm)	Percent of Sample
0.00154	42.5
0.00245	5.0
0.00397	11.5
0.00598	4.0
0.00790	6.0
0.04150	18.0
0.1120	4.0
0.290	4.5
1.210	3.5
3.380	0.5
8.730	0.5
	100.0

classification could be due to site locations or it may be due to the different analytical techniques. The gradation analysis used by MSU should be more useful in evaluation of soil particle size ranges available for transport by surface runoffs, due to the greater number of particle size classes as compared to the agronomic classification of particles into general categories of sand, silt, and clay reported by Gilley et al. The clay loam material had a SAR (sodium adsorption ratio) of 37 which is very high. Clay soils with SAR > 10 tend to disperse when wetted and thus inhibit infiltration.

The Purdue rainfall simulator was used to apply 2.5 inches of water to the plot area in a one hour period. This event yielded 1.69 inches of surface runoff. Soil loss for this event was 5.94 tons/acre.

The CSU Road Sediment Model predicts water and sediment yields for 1 foot wide segments of road surfaces, cut slopes, and fill slopes. Length of each segment is an input parameter for the model and total width of the flow unit is controlled by the lateral inflow of these overland flow segments into ditches of prescribed length. The routing of these overland flow units into ditch or culvert flow units is done according to the geometry of the road prism. The test case chosen had a single overland flow unit with no ditch or culvert flow sections. The one foot wide routing segment used had a total length of 72.6 feet which is equal to the erosion plot length. The 60 minute storm event was divided into 1/2 minute time increments for computation of water routing, sediment transport, and particle detachment. A 90 minute computation period was used for routing. Evaporative losses were assumed negligible and infiltration for the test was then the difference between the water applied (2.5 in.) and the water yield (1.69 in.) which equalled 0.8 in.

With the above information it was possible to make preliminary runs with the CSU Road Sediment Model. The first test on a 10% slope was used to gain familiarity with the inputs of the model. Test #2 on a 4.6% slope was used to "calibrate" the model to a known data set. The final test (#3) is used to demonstrate the prediction accuracy of the calibrated model on a new slope of 17%. The procedure used will follow.

The values for grain resistance (K_o), flow resistance (K_g), raindrop splash detachment coefficient (D_r), and soil detachment coefficient (D_f) are empirical and were selected from information provided by Dr. Li (personal communication). The values for K_o and K_g are given in Table 2.

Dr. Li suggested that in consecutive test runs on a specific plot constant values could be assumed for K_o and K_g. In the North Dakota example, both the surface roughness of the cultivated plots and the grain resistance of the soil was assumed constant. The values selected for K_o and K_g were 50.0 and 400.0, respectively. In the first run, a value of 0.0001 was selected for D_r and D_f was set at 0.01. In consecutive runs the values of D_r and D_f were adjusted by interpolation of program output to final values of 0.0004 and 0.014. The raindrop detachment coefficient D_r is very sensitive and it was adjusted to bring the program output close to the test plot result while D_f was held constant at 0.01. Once the output was close to the test results, D_r was left constant and D_f was adjusted to 0.014 to give the correct answer.

Table 2. Grain Resistance Coefficients and Flow Resistance Coefficients (Li, personal communication)

Grain Resistance (K_o)	Suggested Ranges	Commonly Used Values or Averages
Perfectly smooth surface		24
Concrete surface	30 - 50	35, 40
Asphalt surface	30 - 60	40, 45
Perfectly smooth soil surface		50
Flow Resistance (K_g)	K_ℓ(min)	K_h(max)
Gravel surface	300-400	800
Grass sparse	4000	
Grass dense	40,000	70,000
Bare soil rilled surface	100	120
Tilled bare soil	300	1,000

This test was made primarily to gain familiarity with the road sediment model. Results are shown in Table 3. (The actual computer run is given in Appendix II.) Figures 3 and 4 show the hydrograph simulation of water and the sediment yield for the runoff period. Figure 5 is a comparison of the actual hydrograph for the test plot (ref. #31) with the model

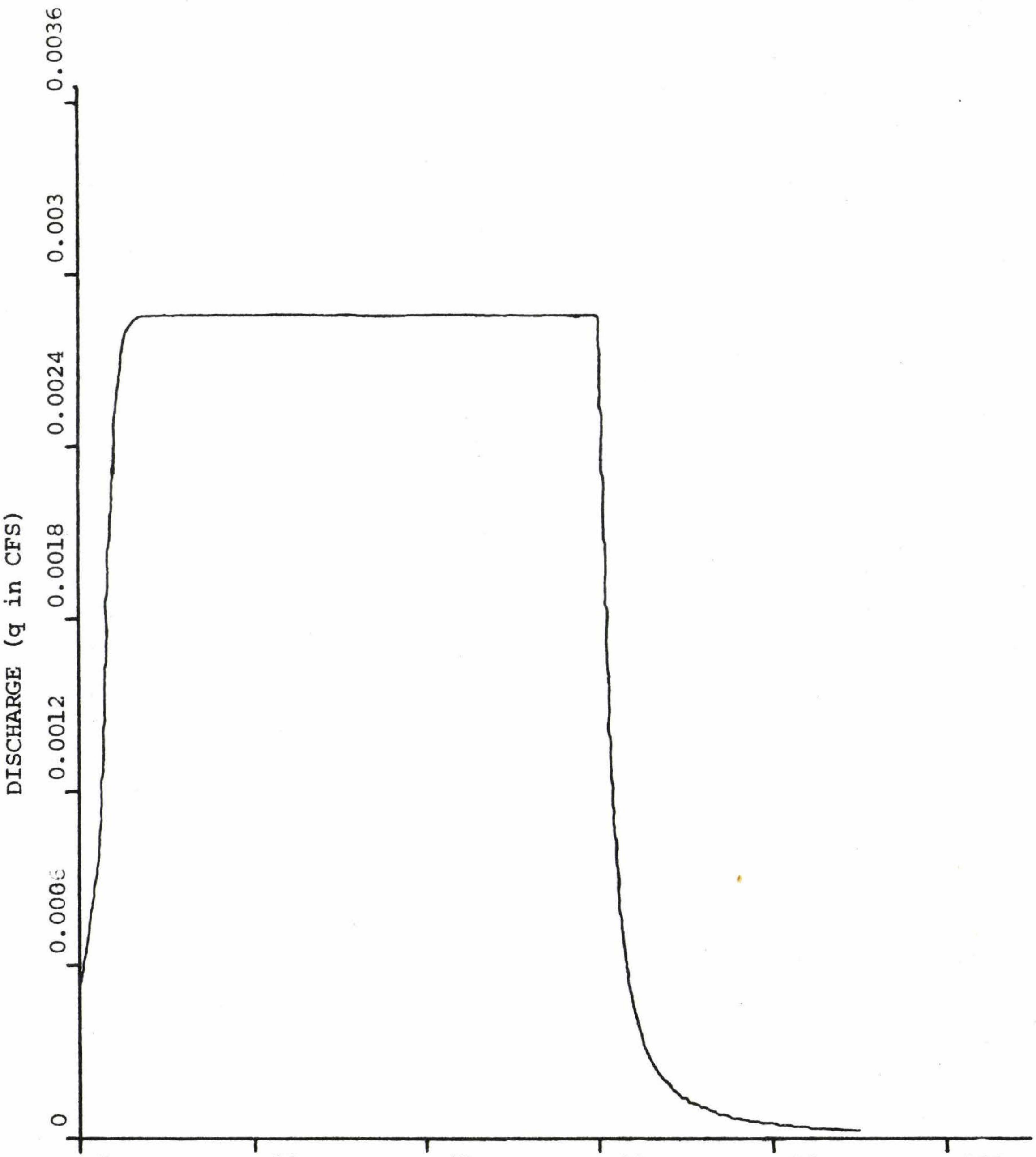

Figure 3. The predicted surface runoff hydrograph from the ROSED Model on a 10% slope. Rainfall intensity was 2.5 inches/hour and duration was one hour.

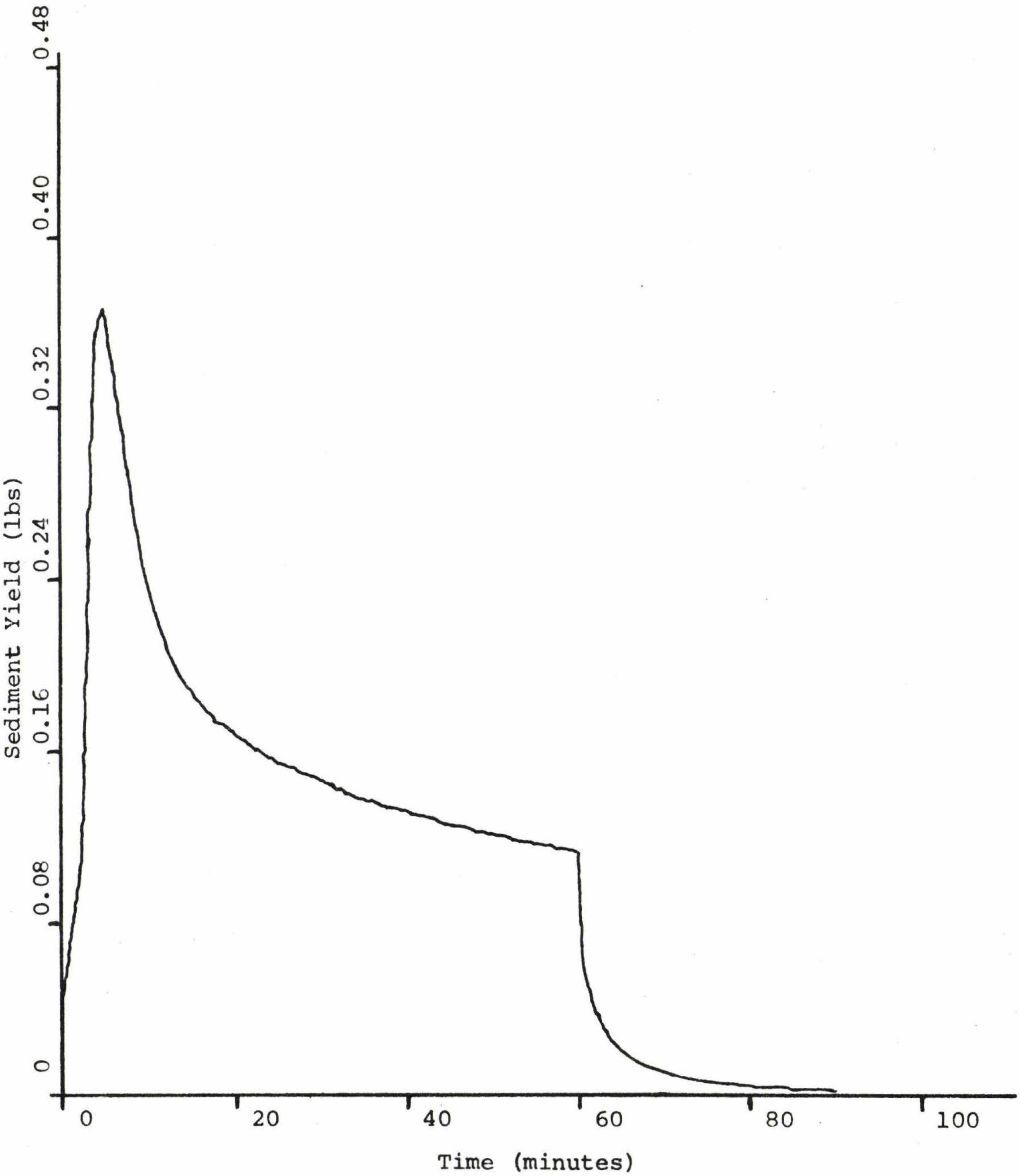

Figure 4. The predicted sediment yield from the ROSED Model on a 10% slope.

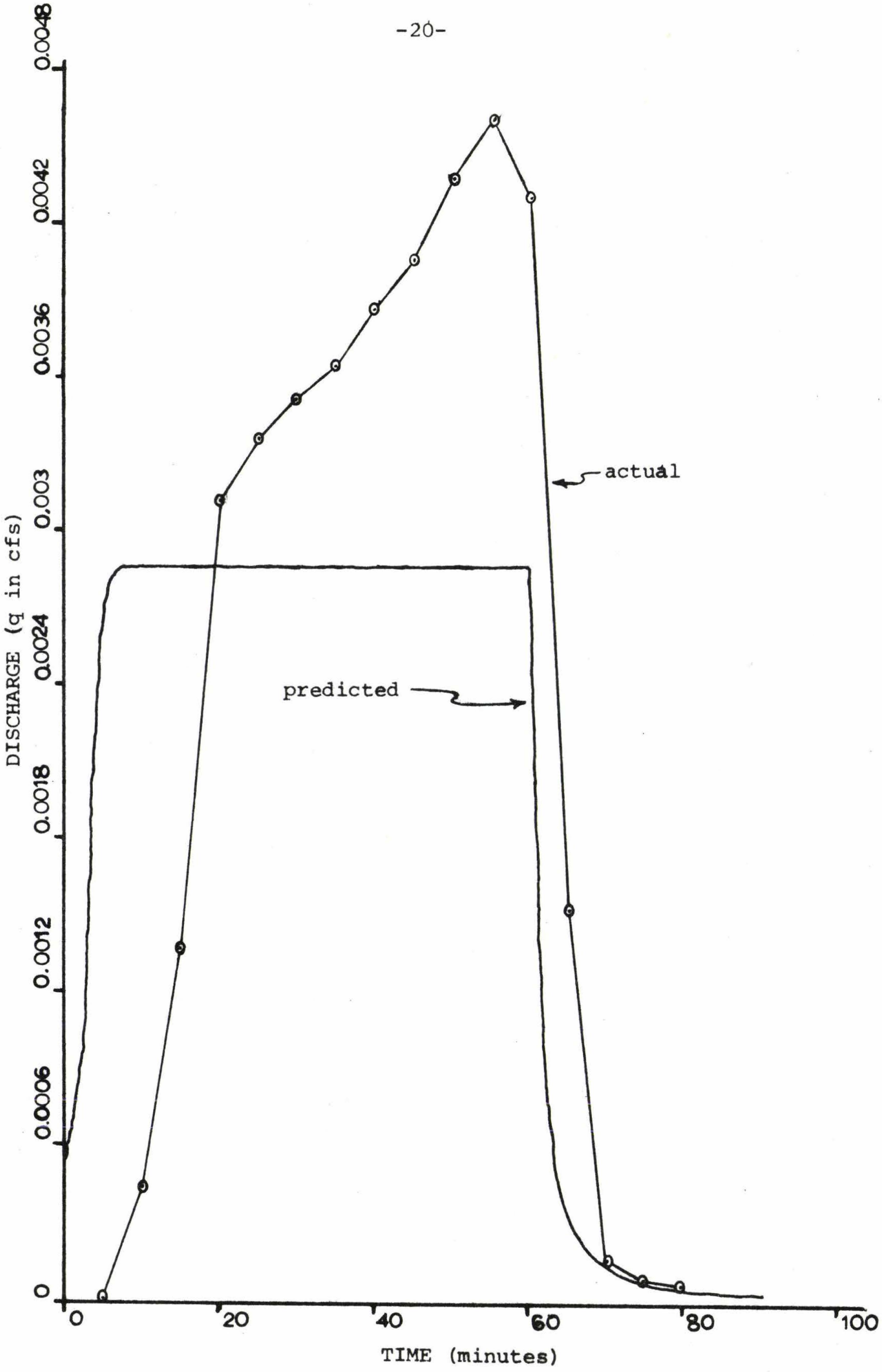

Figure 5. A comparison of the predicted and actual hydrographs from the 10% slope erosion plot.

Table 3. A Comparison of Road Sediment Model Sediment Yields with Actual Test Plot Data for 10% Slope

	Erosion Plot	CSU ROSED Model
Water Yield		
(a) inches of runoff	1.69	1.686
(b) ft^3/acre	6145.2	6120.0
(c) 72.6' x 1.0' segment (ft^3)	10.24	10.2
(d) 72.6' x 13.3 erosion plot (ft^3)	136.22	135.66
(e) 72.6' x 1.0' segment (lbs)	639.11	636.48
Sediment Yield		
(f) tons/acre	5.94	5.94
(g) 72.6' x 1.0' segment (lbs)	19.81	19.80
(h) 72.6' x 13.3' erosion plot (lbs)	263.5	263.34
Ratio $(\frac{e}{g})$ x 100 = %	3.1	3.11

prediction. The total volume of water in the two hydrographs is approximately the same. However, there is a significant difference in the timing and shape of the two hydrographs. There is no precipitation intensity data available from the Purdue rainulator. There is a possibility that the intensity may have been increasing during the one hour test. This could be a reason for the peaked hydrograph. Another effect on hydrograph shape that cannot be accounted for at this time is the infiltration rate. From the available data it is possible to determine the total combined losses to evaporation and infiltration but the rate of infiltration during the test period is unknown and evaporative losses cannot be accounted. A higher initial infiltration rate would help to retard the timing of the rising limb of the hydrograph. These adjustments in the input data can be made to help delay the timing of surface runoff relative to the beginning of precipitation. These changes might help the model yield a better approximation of the actual hydrograph.

The North Dakota study also included rainulator tests on two cultivated plots for a sandy clay loam spoil material. One of these plots had a slope of 4.6% and the other plot slope was 17%. The Purdue Rainulator was again used to apply water at an intensity of 2.5 in./hr for 1.0 hour. The runoff amount for the 4.6% slope was 1.5 inches and the infiltration was assumed as 0.987 inches. For the 17% slope, runoff was 2.2 inches and infiltration was set at 0.291 inches.

A soil sample from the sandy clay loam plot sites was not available for a particle size analysis. As a consequence, the same sieve analysis for a 10% slope clay spoil was used for the Road Sediment Model as in the prior test. The grain resistance (K_o) and flow resistance (K_g) were set at 50 and 400, respectively, since soil surface conditions were similar to those in the first test.

The rainfall detachment coefficient (D_r) and detached soil coefficient (D_f) were set at 0.0001 and 0.01, respectively. These two values were again used to adjust the model output to the test plot sediment yield on the 4.6% slope. The final values for D_r and D_f on the 4.6% slope were 0.0001 and 0.00957, respectively.

After the correct sediment yield was predicted with the model for a 4.6% slope, the input data set was modified for the 17% sandy clay loam plot. The changes necessary for this test were (a) slope $0.046 \rightarrow 0.17$, (b) infiltration $0.987 \rightarrow 0.291$. The values of K_o, K_g, D_r, and D_f were left at the same setting as that on the 4.6% slope. The purpose of this trial was to see how accurately the Road Sediment Model could predict sediment yield for the same soil type on a different slope.

The road sediment model predicted a sediment yield of 5.7 tons/acre compared to 3.75 tons/acre from the actual test on the 17% slope (see Table 4 and Appendix II). The plot data showed a ratio by weight of sediment to water of 1.5%, the corresponding model prediction was 2.29%.

These results are very encouraging. With the recent availability of the actual test plot hydrographs, it may be possible to improve the model predictions by adjusting the routing of runoff. Wet sieve analysis of the spoil material from the individual plots will also be available in the near future. This data should also improve the accuracy of the Road Sediment Model.

More empirical data is also needed about the coefficients K_o, K_g, D_r, and D_f for a more precise application of the model. A method for calculating these coefficients would be very useful. If this is not possible then a complete listing of characteristics which influence these parameters and the corresponding value of the coefficient is needed.

The data selected may have been a poor test example for the CSU Road Sediment Model due to its lack of specific road prism information for the model. However, this was the only data from a mine site that was readily available. The data was useful in gaining an initial understanding of the operations and applications of this model.

Conclusions

On site measurements from road prisms are needed if this model is to be used for accurate selection of the design alternatives which will produce the

Table 4. A Comparison of Road Sediment Model Sediment Yields with Actual Test Plot Data on (a) 4.6% Slope and (b) 17% Slope

	a		b	
	Erosion Plot	CSU ROSED Model	Erosion Plot	CSU ROSED Model
Water Yield				
(a) inches of runoff	1.5	1.5	2.2	2.2
(b) ft^3/acre	**5430.71**	**5430.0**	**8003.15**	7980.00
(c) 72.6' x 1.0' segment (ft^3)	9.05	9.05	13.34	13.3
(d) 72.6' x 13.3' erosion plot (ft^3)	120.38	120.37	177.40	176.89
(e) 72.6' x 1.0' segment (lbs)	564.79	564.72	832.33	829.92
Sediment Yield				
(f) tons/acre	2.03	2.06	3.75	5.7
(g) 72.6' x 1.0' segment (lbs)	6.78	6.87	12.48	19.0
(h) 72.6' x 13.3' segment plot (lbs)	90.14	91.37	166.05	252.7
Ratio $(\frac{e}{g})$ x 100 = %	1.2	1.22	1.5	2.29

least sediment rather than only a determination of how much sediment will be produced. Field data needs for refinement of the CSU Road Sediment Model are primarily concerned with soil properties. Some of the soil properties that are needed are an engineering type wet sieve analysis for complete breakdown of the distribution of soil particle sizes, including a hydrometer analysis of the silt and clay fractions. Another area of concern is the on site measurement of infiltration rates for the derivation of soil hydraulic conductivity and the average suction head across the wetting front for use in the Green-Ampt infiltration equation. Also, hydrographs from road surfaces, cut slopes and fill slopes are needed to refine the routing portions of the model.

The CSU Road Sediment Model will have much utility in the SEAM Mine Planning System for prediction of hydrologic properties of haul roads, the evaluation of different road design criteria, and in the comparison of different route locations. With good on site data and proper refinement of the input variables, it may be possible to do quantitative assessments of haul roads. The fact that this model can be operated with very limited on site data makes it possible to make preliminary assessments of different road design alternatives on a relative basis. This would not be possible with a stochastic model because it would require statistical relationships of the site specific hydrologic properties to operate such a model.

The CSU Engineering Research Center has also developed a physical process watershed model (11). The long-range plan of the developers is to merge the Road Sediment Model with the watershed model. Hopefully, this combined model will be well adapted to assessing the hydrologic impacts of road location and design on the watershed. The model would then have an even greater value for use in the SEAM Mine Planning System.

Regression Equation by Younkin

In May of 1977, an Interim Report by Larry M. Younkin (12) was made available to the MSU group. This Pennsylvania-based study has been conducted for the purpose of developing an equation to predict the suspended sediment loads carried by a stream during periods of rainfall-induced erosion of disturbed soils common to highway construction.

As stated, the purpose of the study is somewhat specialized; that is, the focus is on sediment yield in the stream due to overall watershed runoff changes caused by construction. However, it is possible that the model has utility in predicting direct soil losses from roadway sections or portions. This could be done by compartmentalizing the roadway and separating stream sediment with a delivery ratio. As the compartments decrease in size, the area of study begins to be centered on portions of the roadway prism. Personal discussions with Gary Connelly (13) of the Pennsylvania Department of Highways revealed that he is presently working with Younkin in an attempt to compartmentalize the model. This effort is being done on a small stream that closely parallels a 2-lane highway in Lycoming County. Data available include 1-1/2 years of preconstruction figures on sediment loads and turbidity monitored by a continously recording USGS station(s). Data on rainfall, soils and cover are also available.

The close proximity of the stream to the highway should result in high delivery ratios--the ratio of sediment yield in a stream to the soil loss from its drainage basin. As the delivery ratios approach unity, the stream sediment yields should compare favorably with soil loss values from the roadway drainage areas. These soil losses could be obtained by measurement or computed with the Universal Soil Loss Equation (1) or computed with the CSU Road Sediment Model. Verbal arrangements have been made with Gary Connelly to obtain his data so that such correlations can be made at MSU. Hopefully, this can be accomplished by the end of summer, 1977. Certainly, these correlations would quicken the testing of the CSU model.

To give this report greater coherence, a brief description of Younkin's equation is given here. For details of parameter development, the reader is directed to the reference (12). More detailed discussions will be given in future reports, should the correlations, referred to above, prove fruitful.

Younkin's model is a regression equation as follows:

$$Q_s = C \frac{(EI)(\text{Log } A)^{2.80}(1.93)^D}{P^{0.66}}$$

where: EI = rainfall factor, the total kinetic energy times the maximum 30-minute intensity of a storm.

A = exposed surface area term, the cleared and grubbed area.

D = earthwork term, the average height of cut or fill work.

P = proximity factor, P, the location of construction relative to stream.

Q_s = total suspended sediment transported past a point in the stream system during a storm event.

C = coefficient reflecting soil erodibility, natural terrain and natural cover.

The model has the advantages of simplicity of form and relatively few parameters. Too, most of the parameters are easly obtainable from the construction plans or site. The EI term is the same as that used in the Universal Soil Loss Equation, for which an appreciable amount of information exists. The main disadvantage, at the present time, is that the equation is site specific. It was developed from two study areas and the C coefficient reflects only two sets of conditions of erodibility, terrain and cover. There is currently activity in Pennsylvania aimed at applying the equation to several additional sites. Applicability will be tested and a better understanding of the range of C coefficient will be gained.

Another potential limitation is the D factor, the average height of cuts and fills. This factor represents the effect of slope length on overland flow. Representing slope length by a height factor is possible because of the standardized relationships between slope heights and slope gradients in conventional highway design. The regression equation will not apply to situations where standard slope designs are not in use. In the case of haul roads, close scrutiny of the slope design would be necessary when attempting to apply the model. Perhaps some standardization of haul road design may be in the making, as evidenced by a recent publication by Stauffer (14). The publication is entitled "Surface Mine Haulage Road Design" and attempts to define needs and procedures for proper design.

In summary, the Younkin equation may prove to be a valuable tool in assessing sediment impacts due to road construction. Certainly, those responsible for implementing impact models would find their work eased by such a model form. Further developments and testing are warranted.

Snowmelt Modeling

The complexity of developing a mathematical expression to predict sediment yields and water quality changes stemming from the melting of snow is enormous. Consider that the literature is limited in information related to methods of predicting water yield from snowpack on natural terrain. Add the difficulty of differentiating these water yields into surface runoff, streamflow and ground water recharge, and the complexity grows. Next, determine the amount of sediment induced by the surface runoff; and then place all of these phenomena in the micro-environment of a disturbed roadway system. The complexity issue can be further examplified by noting that the extensive ASCE manual, Sedimentation Engineering (15), contains only three minor comments on the subject of snowmelt.

This is not to say that snowmelt is not important to sediment and water quality. Melting of snow and subsequent runoff can result in large amounts of water and sediment yields. This is particularly true during freeze-thaw cycles at perimeters of snowpack accumulation where weathering and loosening of the soil surface has occurred. During 1972-74, snowmelt runoff (April-July) accounted for 65 percent of the water and sediment discharge from highway cut slopes in the Lake Tahoe Basin, California (16). It is suspected that such values could be attained or exceeded in sub-alpine and alpine areas proposed for surface mining. Areas such as the Beartooth Plateau of southwestern Montana and the phosphate mining areas of southeastern Idaho may be examples. While coal surface mine areas of the Great Plains are likely considerably less affected by snowmelt runoff, the amounts of percentages of yields are not known.

Efforts in snowmelt modeling by the MSU group have been aimed at reviewing the literature and gathering other available information. Results to date are inconclusive as regards sediment yield prediction modeling. However, gains have been made in understanding the general processes and potential magnitudes of these processes involved during snowmelt. Burroughs (32) presents a fine discussion of a case study performed on timber roads near the Idaho-Montana border. The study was successful in differentiating overland flow from total water yield. For a six-day period June 1967, overland flow averaged 42 percent of total yield. No attempt was made to measure sediment yields from these overland flows. The main factors controlling overland flow found by Burroughs are noteworthy and are given as follows:

(1) a deep snowpack,
(2) a snowmelt delayed because of elevation and aspect until the period of maximum incoming solar radiation (June) which melts the snow rapidly and releases a large quantity of snow water in a short period,

(3) a moderately sloped terrain,
(4) a completely saturated soil mantle or a high water table that is not only a function of the prevailing climate but of the glaciated landform as well.

In view of these factors, it is suggested that under normal climatic conditions, snowmelt may not be an important force in sedimentation in the Great Plains. Mine areas in the high elevation areas adjacent to the Rocky Mountains would be the exception.

Modeling of snowmelt has, understandably, been oriented towards the prediction of water for mankind's varied uses. One such model has been developed by Leaf and Brink (17), and is currently being studied for application to appropriate surface mine areas. The model is site specific in that it was developed for a Colorado subalpine forest. Leaf has also just published (June 1977) a document which describes engineering guidelines for predicting erosion and sediment yields from mining activities in subalpine areas (18). The report contains an up-to-date treatment of snowmelt and reflects the extensive experience of Dr. Leaf on the subject of snow hydrology. Study of the report is being done but time has not permitted a written review at this time.

To date, the only data found which pertains to sediment yield from snowmelt runoff is the data from the Lake Tahoe Basin (16). The objective of this study was to determine the sources of sediment contribution to Lake Tahoe. The California Department of Transportation was involved in determining the role of its highways in sediment production. The report, therefore, does not attempt to correlate sediment yield with roadway features, but was more concerned with lump sum production. It is hoped that the road designs can be obtained and correlated to the sediment yields. Soil and climatic data are also being sought. Simple climatic data (degree-days, precipitation) are important as the driving variables to a snowmelt modification to any sediment model that might be selected.

Other snowmelt data may be forthcoming from field instrumentation of the phosphate surface mine areas of southeastern Idaho. Robert Johnston (Forest Service, Logan, Utah) has installed instrumentation to collect runoff and sediment data. While not designed specifically for winter conditions, the instruments may provide data during snowmelt runoff. Climatic and soil data are also being sought.

In short, snowmelt-sediment yield modeling is in an infancy stage or barely conceived. Abstract energy models for snowmelt water yields are potentially applicable. However, the story is the same--data are limited.

WATER QUALITY MODELING

Introduction

In developing an energy resource such as coal, changes are made to the topography of the mined area and to the surrounding land. One change is a network of coal haul roads used to transport the coal, supplies and equipment to and from the mine.

The haul roads that are built for use by the mine can expose large areas of barren cut/fill slopes not to mention the roadway itself. These disturbed areas of land affect the hydrologic and water quality characteristics of the watershed in which they are located. Change in water quality due to haul roads is the subject of this section of the report.

Background

Haul roads used in mining carry a variety of traffic from normal automobiles to large dump trucks. Due to the variety of traffic and constant use, these roads are usually wide, well-maintained and possibly treated with oil to reduce dust. Since they must be used by large equipment at moderate speeds, large cuts and fills may be necesary for smoothing a rolling topography surrounding a mine.

During a rainstorm, the soil surfaces exposed by the road being built are subject to two types of runoff. Surface and subsurface runoff from the roadway and road slopes will be different in chemical and physical makeup than runoff from the native landscape. Due to the limited contact (or exposure) to the soil surface, the following changes in quality might be expected between precipitation and surface runoff: 1. dissolved solids concentration only slightly increased, 2. addition of varible and fluctuating amounts of pesticides, 3. an increase in sediments and other colloidal materials, and 4. other debris from the roadway itself (possibly deposited substances from traffic: road oils, trace engine emission deposits). Subsurface runoff (or interflow) will have slightly different quality changes such as: 1. considerable increase in dissolved solids concentration, and 2. little or no sediment or colloidal material.

Due to the compact state of the haul road surface, there would be little or no interflow runoff. Some surface runoff from the roadway should infiltrate into the road fill providing some interflow runoff. There may also be some interflow and surface runoff from the roadway cut slope.

Past Work in Runoff Chemistry

In the past, many articles have been written describing nutrient and pesticide losses from agricultural plots (19,20,21,22). Recently, efforts to quantify the loss of pesticides from farm land have produced several mathematical models. Very little work has been done to model the water quality changes associated with construction and operation of roadways in watersheds. Although some data has been collected showing water quality changes, modeling of these changes has been limited to fitting an equation to data collected from one situation.

Some early work in runoff chemistry was done by Kohnke (23) in which he described the fluctuating nature of ion concentrations in runoff water. He found that all ions showed somewhat higher concentrations in the beginning of a runoff event than while the runoff was at its peak rate. Calcium and bicarbonate ions increased gradually in concentration as the rate of runoff decreased while chloride decreased steadily. Sulfate, nitrate and potassium were found to be very uniform in concentration during the rainfall incident.

During and after precipitation, the runoff chemistry would change. Initially, surface runoff would dominate the water quality characteristics. As interflow runoff increases, the water quality composition changes. Though calcium and bicarbonate were the predominant ions, their concentrations were low during high surface runoff and high at low percolate runoff. Their initially high concentrations were due to saturation of soil water with these ions which then was picked up by surface runoff at the start of the precipitation.

Calcium is present in runoff as a soluble salt and in colloidal exchange complex (attached to soil particle surface). During periods of high runoff (sediment present) calcium occurs in both forms. As interflow increases and surface runoff stops, only the soluble form is present. This also holds for other cations found in soil.

More recently, a model for runoff of pesticides from small watersheds has been developed (24). The model describes runoff of three materials: water, sediment and chemicals. Although this model operates using a series of calculations, it is not simply a "piggy-back" structure of a chemical model on a sediment model on a water runoff model.

In the water model, a characteristic function was developed for the watershed. This function describes potential runoff from a watershed by summation of incremental grid areas superimposed on the watershed. The runoff from each area and its travel time to a specified watershed outlet are used to plot a runoff versus time histogram. The routing capacity of the watershed was used to modify the characteristic function.

The sediment portion of the model was developed from concepts of rill and interrill erosion. Interrill (soil surface) erosion is a function of rainfall impact. Similar to the water portion, a characteristic function for soil erodibility from the watershed was developed using a grid network. A histogram of erosion potential versus time results. Values for the erosion potential versus time results. Values for the erosion potential were scaled empirically from data collected in the field during runoff events. The rill erosion from the watershed is a function of the tractive force of the flowing water at a point. Since the flow varies over the watershed, the rill erosion was taken as an area-averaged effect. The rill erosion was found considering it a function a discharge and rate-of-change of discharge. Therefore, the rill erosion increased as runoff increased and vice versa.

The third component of the model is the chemical portion. Pesticides may be removed from the soil by dissolution, desorption from soil surfaces, and suspension of particulate matter. These processes of removal are highly dependent on the pesticide chemistry. The authors of this model doubted if theory could be used to predict amounts of pesticide runoff. It was not felt that the pesticide runoff concentration would reach an equilibrium or steady state condition because of the brief time of the runoff event. For this reason, they made the simplifying assumption that the total pesticide concentration in the runoff would be proportional to the pesticide concentration in the soil erosion zone and the amount of sediment transported in the runoff. No attempt was made to differentiate between pesticide attached to a soil particle and that in the runoff water.

After evaluation of required constants for a given watershed, the model was field tested. The authors concluded that adequate simulation of pesticide runoff was achieved using the relationship just described. However, they felt the relationship was only applicable to pesticides which were strongly attached to soil particles (relatively immobile). Runoff amounts of soluble chemicals could be estimated only after considering the portion lost through interflow.

C. B. McWhorter developed a model for determination of water quality in a disturbed watershed (25). His work was done on estimating the change in dissolved solids concentration in runoff from a watershed disturbed by mining a portion of it. The water quality was monitored for three years in four small watersheds disturbed by mining. Using data collected during this period, the following expression was derived:

$$P_t = \frac{P_n KR + f_{sm} P_{sm} + (1-f_{sm}) P_{gm}}{1 + KR}$$

where: P_t = average total dissolved solids (TDS) concentration in total drainage from the watershed

P_{gm} = average surface TDS conc. in drainage from the disturbed portion

P_n = average TDS conc. in drainage from the natural position

$K = \frac{1 - fen}{1 - fem}$

$R = \frac{1-Fm}{Fm}$

f_{sm} = fraction of total runoff from disturbed ground that is surface runoff

F_m = ratio of disturbed area to total watershed area

f_{en} = fraction of precipitation that is consumptively used on the natural portion of the watershed

P_{sm} = average interflow TDS concentration in drainage from the disturbed portion.

f_{em} = fraction of precipitation that consumptively used on the disturbed portion of the watershed.

To use this equation, McWhorter measured values for P_{gm}, P_{sm}, P_n, and F_m. Values for f_{sm} and K were estimated.

Approximating Water Quality Changes

In order to estimate the effect haul roads have on adjacent surface water quality, many factors must be considered. Chemicals can be increased in the runoff water in much the same manner as pesticides are picked up from agricultural plots. The amount and type of chemicals accumulating in the runoff water is a function of the amount of surface runoff from the road and road slopes, the amount of interflow runoff, the type of material used for the road (native or imported), the amount of sediment, the duration and intensity of the storm event, and the distance to the waterway of interest.

Low-mobility chemicals such as heavy metals may be considered in the same manner as pesticides. Since the absorption capacity and chemical reactivity of the soil increase with a smaller soil (sediment) particle size, the amount of the low-mobility chemicals carried away by sediment runoff is a function of the particle size distribution of the eroded soil (26). This could be especially useful in estimating the amount of lead (deposited by vehicles) that is carried to the waterway with eroded soil.

The equation developed by McWhorter for estimating the increase in total dissolved solids in the runoff of a disturbed watershed might also be spplied to haul roads in a watershed. Although use of this model requires determination of several parameters, it could be used as an initial estimation of haul road impact.

The largest problem is faced when attempting to model the high-mobility chemicals available from the soil. As stated earlier, the major reason for lack of modeling success is that the water is normally not exposed to the soil long enough for chemical equilibrium to be achieved. Also, some chemicals attached to sediment particles may be desorbed to the water or the sediment eroded from the roadway may never reach the waterway. Sediment delivery may not be in equilibrium. "Material is eroding rapidly in some areas of the basin and accumulating elsewhere in an episodic and erratic way. The storage of sediment in channels may mask delivery for some period of time" (27). Since the sediment carried by surface runoff will greatly control the quality of this portion of water, sediment delivery from haul roads is important.

Conclusions

"The highly variable, temporal and special character of erosion and sedimentation processes must be emphasized in the predicting exercise of environmental impact assessment. Validation or testing of the predictive capacity of our current knowledge can only be achieved by field observation" (28). Adequate data showing the impact of a secondary roadway on water quality was not found in completing a literature search.

Since water quality degradation by haul roads seems to be so site specific, the most feasible method of modeling would appear to be to collect the required data for development of a model from a haul road site. It is believed that a realistic model cannot be developed from a literature search without field data and verification.

STATUS OF POTENTIAL DATA SOURCES

Since, throughout this report, frequent mention has been made of the importance and limitation of data, it is appropriate to outline promising sources of data. It is felt that the search for sources, throughout the country, is fairly complete. The search has narrowed down to five, possibly six, sources that are specifically related to roads. Brief discussions are given as follows:

California Department of Transportation

Communications have been maintained with Richard Howell of the Office of Transportation Laboratory. Translab has a water study funded by the Federal Highway Administration. The study involves the instrumentation of road projects in California to determine the quantitative effects of road systems on the water resource. In addition, data has been collected on roadway slopes from the aforementioned Lake Tahoe area. As stated, the Tahoe data has to be correlated to the roadway parameters. A project has been developed specifically to measure sediment transport from roadway slope and ditch sections. This project is near Dunsmuir on Interstate 5 and involves Hedge Creek. The instrumentation was completed in time to collect data during the 1977 'runoff season'. Unfortunately, the winter drought resulted in no appreciable flows and consequently, no sediment samples were obtained. This project has been heavily counted upon to produce representative data for model testing. A drought of such consequence is extremely rare, and it can only be hoped that runoff events will occur in the near future.

Translab has been successful in collecting chemical data on roadway runoff from three sites. The chemical constituents have been determined and quantified. The data are expected from Translab within the next few days for use in finalizing selection of a water quality model.

Pennsylvania Studies

There are two sources of data in Pennsylvania, one of which is the aforementioned study by Younkin and Connelly. The other study involves Dr. Art Miller of Penn State University, with whom communications have been maintained since April, 1976. Dr. Miller has been studying small, instrumented watersheds on interstate highways. The watersheds are approximately two square miles in size, and are traversed by the highway sections. At distances approximately 400 feet downstream from the sections, instruments are collecting data on runoff, sediment, turbidity, and rainfall. By mid-July, 1977, a copy of the taped data is expected, with which further testing of the sediment models will be done.

Kentucky Study

In June of 1975 a report was published, Demonstration of Coal Mine Haul Road Sediment Control Techniques (30). The study was funded by the Environmental Protection Agency through the Kentucky Department for Natural Resources and Environmental Protecton. Resulting from this study, has been the development of a second study in which quantification of sediments is the objective. An undisturbed watershed in eastern Kentucky is to be extensively instrumented to measure sediment yields under various control techniques, including no control. Communication with the Kentucky people includes a visit to their headquarters in Frankfort, during a sediment conference in Louisville in July, 1976. At that time, installation of the project was to begin. However, delays have occurred, and final approval and funding was not accomplished until May 1977. Installation is now proceeding.

The Kentucky study will collect data on haul roads of similar design to those on Western coal lands. While climatic, terrain and soil conditions will be substantially different, the data still should be of use in model testing.

U.S. Forest Service

Under SEAM Engineering Research Project 1652 is a sub-study to be conducted by Robert Johnston of the Forest Service's Logan, Utah station. The primary objectives of this study are to collect data on water yield and water quality of surface runoff from mine-related haul roads; and to correlate the effects of roads on water yield and water quality to parameters of the road.

Field installations to collect water quality and surface runoff data have been installed at two locations. One of the sites is in southwest Idaho on the phosphate surface mines, and the other is in a high rainfall area of western Oregon. Data acquisition from the two sites should begin soon, thereby hastening the flow of data for further testing of the Road Sediment Model.

In addition, cooperative rainulator studies on surface mining roads in the Northern Great Plains are scheduled for the fall 1977 and spring 1978. Application of rainfall by artificial means is necessary to overcome the anticipated lack of natural rainfall events during the short time period of the study. Too, scheduling a prescribed amount of rainfall to a road area of known physical characteristics should enhance the understanding of the severable variables of Road Sediment Model.

Other Studies

In this category is listed a newly found source, the Great Lakes Forest Research Center, Sault Ste. Marie, Ontario, Canada. Mr. Nicholson of the Center has an ongoing investigation to quantify changes in chemical and physical properties of surface runoff waters as a result of forest management practices, including forest access road construction.

Preliminary contacts have been made to initiate an exchange of information. The Ontario sites should offer another extreme type of terrain, soil and climatic conditions. Hopefully, there will be data available to test the sediment models.

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APPENDIX I

ROSED COMPUTER PROGRAM

The computer simulation program ROSED, or Road Sediment Model, was developed by researchers at Colorado State University. Although the model was programmed in FORTRAN, there are operations which are handled differently by the FORTRAN compilers of various computers. The University Computer Center at CSU operates a CDC computer whose machine-language words and data codes allow implementations of FORTRAN features not compatible with the computer system at MSU. The Computer System at MSU was a Xerox Data Systems (XDS) Sigma-7 computer and CP-V operating system.

Hence, the original computer code from the CSU report required a number of changes before the published test results could be duplicated. Besides these revisions other considerations were included when converting ROSED for implementation here. Improvements in the output and presentation of results were desired to aid in identifying the simulation control parameters. In general, the purpose was characterization of the general relations between these variables, their typical ranges, effects of variation, and optimum values. After calibration, then, more specific guidelines for application of the Model could follow.

Specific changes began with the addition of identifiers on the output listings. Variable names, general characteristics, and measurement units were included. Alpha numeric variables were modified to conform to Xerox FORTRAN conventions. Integer arrays ITITLE, IDSEG, and ISTORM were substituted for the variables, TITLE, SEG, and STORM. These changes and programmer preference prompted changes to the labeled COMMON blocks in each of the Model's subroutines. Corrections to spelling errors and additional comments also appear in this version.

Presentation of the simulation results was the focus of the final phase in revising ROSED. The distribution of particle sizes in the transported sediment was one form of results reinstated. An option, IPD, was added to control the interval at which the particle distributions are displayed. IPD is given as the number of simulation time-steps between distribution reports during runoff simulation.

Graphic displays are a current feature of the MSU ROSED program. Two save-files may be created during each run with data in these files used to produce plotted sediment and runoff hydrographs and soil gradation curves. The control variables ISV1 and ISV2 if non-zero are given as I/O unit numbers where save-files are to be written. ISV1, set to a disk file, will contain the distribution functions reported at regular intervals during simulation. Likewise, ISV2 is the output for the sediment and water yields at each time-step.

The program, HYDRG, produces plotted hydrographs for each response unit of the simulated watershed. The FORTRAN code for this routine appears in Appendix I along with a load-map. The subroutine DRAW is a program product available through the Computer Center. It produces the graphic displays on the Center's IBM 1627 drum plotter.

A second program, GRADG, is under development. Graphic output from it will be soil gradation charts showing changes in transported sediment using data from the ISV1 save-file. Final testing of this program is being conducted at this time and an operational package will be available soon.

All statements in the Road Sediment Model program, ROSED, which have been added or which have been changed from the original CSU version appear in the program listing without Card Sequence numbers in the last columns. The latest release of the MSU version of ROSED is given in Appendix I.

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THE PROCEDURES DESCRIBED BELOW MAY BE SUBMITTED TO THE
    'BATCH PROCESSING MONITOR' BY ONE OF TWO METHODS.
    1)  FROM AN ON-LINE TERMINAL, ISSUE A COMMAND --
       !BATCH BJFILE  'STRING-1'='NEW-1','STRING-2'='NEW-2',ETC  --
        SUPPLYING APPROPRIATE SUBSTITUTIONS AS INDICATED BELOW,
    2)  PUNCH THE COMMAND-LINES ON 80-COLUMN CARDS,
        SUPPLYING THE SUBSTITUTIONS AS INDICATED, AND
        SUBMIT THE CARD-DECK TO THE MACHINE OPERATOR.
---
TO COMPILE A FORTRAN PROGRAM AND SAVE THE RESULTING
    RELOCATABLE OBJECT MODULE ON A NAMED FILE
    USE THE BATCH-JOB 'BJFORT'.  TWO CONSIDERATIONS
    TO BE REMEMBERED ARE --
    1)  IDENTIFY THE SOURCE PROGRAM FILE BY
       USING THE '$' PREFIX IN THE SOURCE-FILE NAME, EG:
         $MAIN, $HYDRG, $SOURCE
       THE FILE NAME MAY BE SUPPLIED IN THE SUBSTITUTION --
         'AFILE'='HYDRG'      (FOR EXAMPLE)
    2)  THE BINARY OBJECT FILE (ROM) WILL BE PRODUCED
       UNDER THE SAME NAME BUT WITH THE '@' SUFFIX, EG:
         MAIN@, HYDRG@, SOURCE@
       THIS CORRESPONDS TO THE SAME SUBSTITUTION --
         'AFILE'='HYDRG'  IN  '(FILE,AFILE@)'
```

```
EXECUTION OF THE ROSED-MODEL MAY BE CALLED BY USING EITHER
     OF THE TWO PROCEDURES 'BJRUNR' OR 'BJXEOR'.
     'BJRUNR' MUST BE USED FIRST TO ACCOMPLISH THE LOADING
     OPERATION WHICH RESOLVES RELOCATABLE REFERENCES IN THE
     BINARY ROM AND PRODUCES A LOAD MODULE.  THE LOAD MODULE
     IS GIVEN THE IDENTIFIER 'ROSED*' AND IS EXECUTED FOLLOWING
     THE '!RUN (LMN,ROSEO*)'  COMMAND.
     TWO SUBSTITUTIONS ARE NECESSARY TO SETUP THE INPUT-OUTPUT
     FILES.
     1)  THE INPUT DATA-FILE CONTAINING THE SIMULATION
        CONTROL CARDS IS SELECTED BY THE SUBSTITUTION --
          'DATA'='TEST1'  (FOR EXAMPLE).
        ON CARDS THE ASSIGNMENT '(FILE,DATA)' SHOULD BECOME
          '(DEVICE,CP)'
     2)  THE OUTPUT SAVE FILES FOR HYRDROGRAPH DATA AND
        SOIL GRADATION DATA MAY BE SPECIFIED BY THE SUBSTITUTION --
          'ISV1'='FILE-NAME-1' AND/OR 'ISV2'='FILE-NAME-2'

ONCE THE LOAD MODULE IS CREATED THE MODEL MAY BE EXECUTED
     ANY NUMBER OF TIMES WITH DIFFERENT DATA-SETS.  THIS
     IS DONE USING THE 'BJRUNR' PROCEDURE AND SUBTITUTIONS.
---
THE GRAPHIC DISPLAY PROGRAM WHICH GENERATES HYDROGRAPHS
     FROM DATA IN THE SAVE-FILE 'ISV2' MAY BE RUN USING
     APPROPRIATE SUBSTITUTIONS FOR FILE NAMES --
         'ISV1'='FILE-NAME'    ETC.
     TWO PROCEDURES ARE AVAILABLE AS BEFORE --
         'BJRUNG' AND 'BJXEOG'.
```

```
  NAME = BJFORT

!JOB ACCOUNT,NAME,2 .. COMPILE FORTRAN PROGRAM 'AFILE'
!LIMIT (TIME,2),(CORE,10),(ACCOUNT),(ORDER)
!ASSIGN M:SI,(FILE,$AFILE)
!ASSIGN M:BO,(FILE,AFILE3)
!ASSIGN M:LO,(DEVICE,LP)
!FORTRAN  BC,BO
!EOD
!EOD
```

```
  NAME = BJXEQR

!JOB ACCOUNT,NAME,2    .. LOAD AND RUN REVISED 'ROSED'
!LIMIT (ACCOUNT),(ORDER),(TIME,2),(CORE,26)
!LDEV L2,(FORM,4161),(VFC)
!ASSIGN F:105,(FILE,DATA)
!ASSIGN F:108,(DEVICE,L2)
!ASSIGN F:202,(FILE,TSV2),(OUT),(SAVE)
!RUN (LMN,ROSED*)
!EOD
!EOD
```

```
  NAME = RJXEQG

!JOB ACCOUNT,NAME,2    .. LOAD AND RUN HYDRG-GRAPHICS
!LIMIT (TIME,2),(CORE,18),(PO,9999),(ACCOUNT),(ORDER)
!PLOT  PLEASE PLACE PEN AT RIGHT SIDE
!ASSIGN F:108,(DEVICE,L2)
!ASSIGN F:202,(FILE,ISV2)
!ASSIGN M:PL,(DEVICE,PL)
!LDEV L2,(FORM,4161)
!RUN (LMN,HYDRG*)
!EOD
!EOD
```

```
  NAME = RJRUNR

!JOB ACCOUNT,NAME,2    .. LOAD AND RUN REVISED 'ROSED'
!LIMIT (ACCOUNT),(ORDER),(TIME,2),(CORE,26)
!LDEV L2,(FORM,4161),(VFC)
!ASSIGN M:LL,(DEVICE,L2)
!ASSIGN F:105,(FILE,DATA)
!ASSIGN F:108,(DEVICE,L2)
!ASSIGN F:202,(FILE,TSV2),(OUT),(SAVE)
!LOAD (EF,(MAIN@,1126UTIL)),(MAP,NAME,VALUE),(LMN,ROSED*),(PERM)
!RUN (LMN,ROSED*)
!EOD
!EOD
```

```
  NAME = BJRUNG

!JOB ACCOUNT,NAME,2    .. LOAD AND RUN HYDRG-GRAPHICS
!LIMIT (TIME,2),(CORE,18),(PO,9999),(ACCOUNT),(ORDER)
!PLOT  PLEASE PLACE PEN AT RIGHT SIDE
!ASSIGN M:LL,(DEVICE,L2)
!ASSIGN F:108,(DEVICE,L2)
!ASSIGN F:202,(FILE,ISV2)
!ASSIGN M:PL,(DEVICE,PL)
!LDEV L2,(FORM,4161)
!LOAD (EF,(HYDRG@,1126UTIL)),(EF,(XDSPLOT,:USER)),(UNSAT,(EELIB)),;
!(MAP,NAME,VALUE),(LMN,HYDRG*),(PERM)
!RUN (LMN,HYDRG*)
!EOD
!EOD
```

```
  NAME = BJMAPS

!JOB 1126GENL,POOLE,2 .. MAP MODULES
!LIMIT (TIME,4),(CORE,26)
!LDEV L2,(FORM,4161)
!ASSIGN M:LL,(DEVICE,L2)
!ASSIGN M:LO,(DEVICE,L2)
!LOAD (LMN,ROSED*),(MAPONLY,NAME,VALUE)
!LOAD (LMN,HYDRG*),(MAPONLY,NAME,VALUE)
!ECD
!EOD
```

```
C*
C      PROGRAM  ROSED
C
       COMMON /VAR1/  NSEG,NDX,NSTOM,IMAX,MM,
     & IPD,IPD1,ISV1,ISV2
       COMMON /VAR2/  IDSEG(2,10),SLEN(10),SLOP1(10),PERM(10),
     & ALPHA(10),CF(200,10),DMB(10,15),PBO(10,15),GC(10),Z,DIA,DEMAX,
     & D84(10),SSUM,PMC(10),AMC(10),CN(10),GCT,CNI,
     & SINT(10),DNB(10,15)
       COMMON /VAR3/  ISEG(010),IUP(010,3),ILAT(010,2),ITYP(010)
       COMMON /VAR4/  AIM,BIM,AGB,BEX,ADF(10),DELTS
       COMMON /VAR5/  FKL,OFL(10),OFH(10),COEFN,SMU,GRF,ERF
       COMMON /VAR6/  ISTORM(2,05),ITMAX(05),ITCOM(05),DR(05,200),
     & RCUM(10),RRNET(10),RREXC(10)
       COMMON /VAR7/  EGB(15),GBC(15),ZBL(15),GBUP(15),GBLAT(15),
     & BLAT(15),BTEM(15),SB(10,10,15),RB(10,10,15),
     & SLOP(10,10),DDEP(15)
CX     COMMON /VAR8/  A(10,10),Q(100),QP(10,10),PB1(10,15),GBO(10,15)
       COMMON /VAR9/  PORB(15),ZSUM,ASUM,EPS,DT
       COMMON /VAR10/  CPR,EPR,ALP,BET,SLP,ALAT,QUP,AUP,QE,QLAT,
     & AREA,A1(10),B1(10)
C
C
C      ENTRY  ROSED
C
 100   CALL DATA1
       DO 101 KI=1,NSTOM
          CALL INITL (KI)
          CALL ROUTE (KI)
  101  CONTINUE
       STOP
C
       END
```

```
C*
      SUBROUTINE ROUTE (KI)
C
      COMMON /VAR1/  NSEG,NDX,NSTOM,IMAX,MM,
     & IPD,IPD1,ISV1,ISV2
      COMMON /VAR2/  IDSEG(2,10),SLEN(10),SLOP1(10),PERM(10),
     & ALPHA(10),CF(200,10),DMB(10,15),PBO(10,15),GC(10),Z,DIA,DEMAX,
     & D84(10),SSUM,PMC(10),AMC(10),CN(10),GCI,CNI,
     & SINT(10),DNB(10,15)
      COMMON /VAR3/  ISEG(010),IUP(010,3),ILAT(010,2),ITYP(010)
      COMMON /VAR4/  AIM,BIM,AGB,BEX,ADF(10),DELTS
      COMMON /VAR5/  FKL,OFL(10),OFH(10),COEFN,SNU,GRF,ERF
      COMMON /VAR6/  ISTORM(2,05),ITMAX(05),ITCOM(05),DR(05,200),
     & RCUM(10),RRNET(10),RREXC(10)
      COMMON /VAR7/  EGB(15),GBC(15),ZBL(15),GBUP(15),GBLAT(15),
     & BLAT(15),BTEM(15),SB(10,10,15),RP(10,10,15),
     & SLOP(10,10),DDEP(15)
      COMMON /VAR8/  A(10,10),Q(100),QP(10,10),PBI(10,15),GBO(10,15)
      COMMON /VAR9/  PORB(15),ZSUM,ASUM,EPS,DT
      COMMON /VAR10/  CPR,EPR,ALP,BET,SLP,ALAT,QUP,AUP,QE,QLAT,
     & AREA,A1(10),B1(10)
C
C
C     ENTRY  ROUTE( KI )
C
C     INITIALIZE  CONSTANTS
C
 100  IFLAG=0
      IFLGC=0
      IFLGS=0
      ITCOM1=ITCOM(KI)
      DTS=DT*60.
      DTN=DTS*FLOAT(NDX)
      DO 101 K=1,NSEG
         RREXC(K)=0.
         RRNET(K)=0.
  101 RCUM(K)=0.
      PRINT 118, DT,ITCOM1,ITMAX(KI)
      DO 117 IT=1,ITCOM1
C
C     DETERMINATION OF RAINFALL INPUT
C
         IF (IT.GT.ITMAX(KI)) GO TO 102
         RAIN=DR(KI,IT)
         GO TO 103
  102    RAIN=0.
  103    CONTINUE
         DO 115 I=1,NSEG
```

```
            K=ISEG(I)
            CPR=A1(K)
            EPR=B1(K)
            BPER=CPR
            DTX=DTN/SLEN(K)
C
C     DETERMINATION OF INTERCEPTION LOSSES
C
            RCUM(K)=RCUM(K)+RAIN*DT/60.
            IF (RCUM(K).LT.SINT(K)) GO TO 104
            RRNET(K)=(RCUM(K)-SINT(K))/(DT/60.)
            RCUM(K)=SINT(K)
            GO TO 105
  104       RRNET(K)=0.
  105       CONTINUE
C
C     DETERMINE  INFILTRATION  LOSSES
C
            IF (ITYP(K).GT.1) GO TO 106
            CALL INFIL (K,DT,ITCOM1,RRNET,IT,RNET)
            RREXC(K)=RNET
  106       CONTINUE
C
C     DETERMINE  UPSTREAM AND LATERAL INFLOW
C
            CALL UPLAT (K,DTS,RNET)
            IF (ITYP(K).LE.1) GO TO 107
            CALL CAPA (K,QUP,IFLGQ,IFLGS)
            IF (IFLGQ.GE.1) GO TO 116
            IF (IFLGS.GE.1) GO TO 116
  107       CONTINUE
            DO 114 J=1,NDX
               ZSUM=0.
               SLP=SLOP(K,J)
               DO 108 M=1,MM
                  ZBL(M)=SB(K,J,M)
                  ZSUM=ZSUM+ZBL(M)
                  BTEM(M)=RB(K,J,M)
  108          CONTINUE
C
C     DETERMINE  RAINDROP  DETACHMENT
C
               CALL DETCH (K,J,RAIN)
               ALAT=QLAT*DTS
               ASUM=ALAT+A(K,J)+DTX*QUP
               IF (ASUM.LE.1.0E-07) GO TO 111
C
C     DETERMINE THE COEFFICIENT AND THE EXPONENT IN A-Q RELATION
```

```
C
                GO TO (110,110,109), ITYP(K)
  109           CALL CULVT (K)
  110           CALL FRICT (K)
C
C     WATER ROUTING
C
                CALL WROUT (K,J,DTX)
C
C     DETERMINE  THE  PERCENTAGE  DISTRIBUTION OF SOIL  PARTICLE
C
                CALL PERTG (K)
C
C     COMPUTE THE TRANSPORTING CAPACITY
C
                CALL TRANS (K,J,BPER)
C
C     COMPUTE THE SEDIMENT LOAD
C
                CALL SROUT (K,J,DTX,BPER)
                GO TO 112
  111           CONTINUE
C
C     COMPUTE THE SEDIMENT LOAD WHEN RAINFALL ENDS
C
                CALL CEASE (K,J,DTX)
C
C     REDEFINE  VARIABLES  FOR  NEXT  TIME  STEP
C
  112           A(K,J)=AREA
                QP(K,J)=QE
                AUP=AREA
                QUP=QE
                SUMV=0.
                DO 113 M=1,MM
                   GBUP(M)=RB(K,J,M)*QE
                   SB(K,J,M)=ZBL(M)+EGB(M)/BPER
                   GBO(K,M)=GBUP(M)
                   SUMV=SUMV+EGB(M)
  113           CONTINUE
C
C     COMPUTE THE  AGGREDATION DEPTH
C
                DDEP(J)=+SUMV/PORB(K)
  114        CONTINUE
             Q(K)=QUP
             IF (ITYP(K).LT.2) GO TO 115
             CALL AGGDG (K,IFLAG)
```

```
            IF (IFLAG.GT.0) GO TO 116                                          ROU 1370
  115     CONTINUE                                                             ROU 1380
C                                                                              ROU 1390
  116     CONTINUE                                                             ROU 1400
C                                                                              ROU 1410
C       PRINT  THE  RESULTS                                                    ROU 1420
C                                                                              ROU 1430
          CALL DPRNT (IT,DTS,KI)
          IF (IFLAG.GT.0) RETURN                                               ROU 1450
          IF (IFLGQ.GT.0) RETURN                                               ROU 1460
          IF (IFLGS.GT.0) RETURN                                               ROU 1470
  117 CONTINUE                                                                 ROU 1480
      RETURN                                                                   ROU 1490
C                                                                              ROU 1500
 118  FORMAT( 1H1//10X'RUNOFF SIMULATION  BY SEGMENT'
     & /12X'TIME INCREMENT ='F10.3'  MINUTES'6X'( DT     )'
     & /12X'RUNOFF DURATION ='I4'  INCR.'13X'( TTCOM )'
     & /12X'RAINFALL DURATION ='I4'  INCR.'11X'( ITMAX )' /)
C                                                                              ROU 1530
      END                                                                      ROU 1540
```

```
C*
      SUBROUTINE INITL (KT)
C
      COMMON /VAR1/  NSEG,NDX,NSTOM,IMAX,MM,
     & IPD,IPD1,ISV1,ISV2
      COMMON /VAR2/  IDSEG(2,10),SLFN(10),SLOP1(10),PERM(10),
     & ALPHA(10),CF(200,10),DMB(10,15),PB0(10,15),GC(10),Z,DIA,DEMAX,
     & DR4(10),SSUM,PMC(10),AMC(10),CN(10),GCI,CNI,
     & SINT(10),DNB(10,15)
CX    COMMON /VAR3/  ISEG(010),IUP(010,3),ILAT(010,2),ITYP(010)
      COMMON /VAR4/  ATM,BIM,AGB,BEX,ADF(10),DELTS
      COMMON /VAR5/  FKL,OFL(10),OFH(10),COEFN,SNU,GRF,ERF
      COMMON /VAR6/  ISTORM(2,05),ITMAX(05),ITCOM(05),DR(05,200),
     & RCUM(10),RRNET(10),RREXC(10)
      COMMON /VAR7/  EGB(15),GBC(15),ZBL(15),GPUP(15),GBLAT(15),
     & BLAT(15),BTEM(15),SB(10,10,15),RB(10,10,15),
     & SLOP(10,10),DDFP(15)
      COMMON /VAR8/  A(10,10),Q(100),QP(10,10),PB1(10,15),GB0(10,15)
      COMMON /VAR9/  PORB(15),ZSUM,ASUM,EPS,DT
CX    COMMON /VAR10/  CPR,EPR,ALP,BET,SLP,ALAT,QUP,AUP,QE,QLAT,
CX   & AREA,A1(10),B1(10)
C
C
C     ENTRY  INITL( KT )
C
C     INITIALIZE ENTIRE WATERSHED
C
 100  ITCOM1=ITCOM(KT)
      DO 101 M=1,MM
         EGB(M)=0.
         GBC(M)=0.
         ZBL(M)=0.
         BTEM(M)=0.
  101 CONTINUE
      DO 102 I=1,ITCOM1
      DO 102 J=1,NSEG
         CF(I,J)=0.
  102 CONTINUE
      DO 103 N=1,NSEG
         Q(N)=0.
      DO 103 J=1,NDX
         A(N,J)=0.
         QP(N,J)=0.
         SLOP(N,J)=SLOP1(N)
      DO 103 M=1,MM
         GB0(N,M)=0.
         PB1(N,M)=0.
         SB(N,J,M)=0.
```

```
          RB(N,J,M)=0.                                                  INI  380
  103 CONTINUE                                                          INI  390
C                                                                       INI  400
C     COMPUTE THE POROSITY                                              INI  410
C                                                                       INI  420
      DO 105 I=1,NSEG                                                   INI  430
         SUMP=0.                                                        INI  440
         DO 104 M=1,MM                                                  INI  450
            SUMP=SUMP+0.245+0.0864/(0.1*DNB(I,M))**0.21                 INI  460
            DMB(I,M)=DNB(I,M)/304.8                                     INI  470
  104    CONTINUE                                                       INI  480
         PORB(I)=1.-SUMP/FLOAT(MM)                                      INI  490
  105 CONTINUE                                                          INI  500
C                                                                       INI  510
C     COMPUTE THE VOLUME OF INTERCEPTION LOSSES                         INI  520
C                                                                       INI  530
      DO 106 N=1,NSEG                                                   INI  540
         SINT(N)=GC(N)*GCI+CN(N)*CNI                                    INI  550
  106 CONTINUE                                                          INI  560
C                                                                       INI  570
C     COMPUTE THE D84 LAYER                                             INI  580
C                                                                       INI  590
      IF (MM.EQ.1) GO TO 110                                            INI  600
      DO 109 K=1,NSEG                                                   INI  610
         SPERE=0.                                                       INI  620
         DO 107 M=1,MM                                                  INI  630
            SPERE=SPERE+PBO(K,M)                                        INI  640
            IF (SPERE.GE.0.84) GO TO 108                                INI  650
            SPERP=SPERE                                                 INI  660
  107    CONTINUE                                                       INI  670
  108    M84=M-1                                                        INI  680
         D84(K)=(DMB(K,M)-DMB(K,M84))/(SPERE-SPERP)*(0.84-SPERP)
     &             +DMB(K,M84)
  109 CONTINUE                                                          INI  710
      GO TO 111                                                         INI  720
  110 D84(K)=DMB(K,MM)                                                  INI  730
  111 CONTINUE                                                          INI  740
C                                                                       INI  750
      RETURN                                                            INI  760
C                                                                       INI  770
C                                                                       INI  780
      END                                                               INI  780
```

```
C*
      SUBROUTINE INFIL (K,DT,ITCOM1,RAIN,IT,RNET)
C
CX     COMMON /VAR1/  NSEG,NOX,NSTOM,IMAX,MM,
CX    & IPD,IPD1,ISV1,ISV2
      COMMON /VAR2/  IDSEG(2,10),SLEN(10),SLOP1(10),PERM(10),
     & ALPHA(10),CF(200,10),DMB(10,15),PBO(10,15),GC(10),Z,DTA,DEMAX,
     & D84(10),SSUM,PMC(10),AMC(10),CN(10),GCI,CNI,
     & SINI(10),DNB(10,15)
CX     COMMON /VAR3/  ISEG(010),IUP(010,3),ILAT(010,2),ITYP(010)
CX     COMMON /VAR4/  ATM,BTM,AGB,BEX,ADF(10),DELTS
CX     COMMON /VAR5/  FKL,OFL(10),OFH(10),COEFN,SNU,GRF,ERF
CX     COMMON /VAR6/  ISTORM(2,05),ITMAX(05),ITCOM(05),DR(05,200),
CX    & RCUM(10),RRNET(10),RREXC(10)
CX     COMMON /VAR7/  EGB(15),GBC(15),ZBL(15),GBUP(15),GBLAT(15),
CX    & BLAT(15),BTEM(15),SB(10,10,15),RB(10,10,15),
CX    & SLOP(10,10),DDEP(15)
CX     COMMON /VAR8/  A(10,10),Q(100),QP(10,10),PB1(10,15),GBO(10,15)
CX     COMMON /VAR9/  PORB(15),ZSUM,ASUM,EPS,DT
CX     COMMON /VAR10/  CPR,FPR,ALP,BET,SLP,ALAT,QUP,AUP,QE,QLAT,
CX    & AREA,A1(10),B1(10)
C
C
C      ENTRY  INFIL( K,DT,ITCOM1,RAIN,IT,RNET )
C
C
C      THIS SUBROUTINE DETERMINE THE INFILIRATION RATE
C
 100  FGA=CF(IT,K)
      ALP=ALPHA(K)*(PMC(K)-AMC(K))
      BET=PERM(K)
      TBET=BET*DT/60.
      DF=-0.5*(2.*FGA-TBET)+.5*SQRT((2.*FGA-TBET)**2+8.*TBET*(ALP+FGA))
      FRA=DF*60./DT
      IF (FRA.GE.RAIN) GO TO 101
      FGA=FGA+DF
      GO TO 102
  101 FGA=FGA+RAIN*DT/60.
      FRA=RAIN
  102 KX=IT+1
      IF (KX.GT.ITCOM1) GO TO 103
      CF(KX,K)=FGA
  103 RNET=RAIN-FRA
      IF (RNET.LT.0.) RNET=0.
      RETURN
C
C
      END
```

```
C*
      SUBROUTINE DATA1
C
      DIMENSION  ITITLE(20)
C
      COMMON /VAR1/  NSEG,NDX,NSTOM,IMAX,MM,
     & IPD,IPD1,ISV1,ISV2
      COMMON /VAR2/  IDSEG(2,10),SLEN(10),SLOP1(10),PERM(10),
     & ALPHA(10),CF(200,10),DMB(10,15),PBO(10,15),GC(10),Z,DIA,DEMAX,
     & DR4(10),SSUM,PMC(10),AMC(10),CN(10),GCI,CNT,
     & SINT(10),DNB(10,15)
      COMMON /VAR3/  ISEG(010),IUP(010,3),ILAT(010,2),ITYP(010)
      COMMON /VAR4/  AIM,BIM,AGB,BEX,ADF(10),DELTS
      COMMON /VAR5/  FKL,OFL(10),OFH(10),COEFN,SNU,GRF,ERF
      COMMON /VAR6/  ISTORM(2,05),ITMAX(05),TTCOM(05),DR(05,200),
     & RCUM(10),RRNET(10),RREXC(10)
CX    COMMON /VAR7/  EGB(15),GBC(15),ZBL(15),GBUP(15),GBLAT(15),
CX   & BLAT(15),BTEM(15),SB(10,10,15),RB(10,10,15),
CX   & SLOP(10,10),DDEP(15)
CX    COMMON /VAR8/  A(10,10),Q(100),QP(10,10),PB1(10,15),GBO(10,15)
      COMMON /VAR9/  PORB(15),ZSUM,ASUM,EPS,DT
      COMMON /VAR10/  CPR,EPR,ALP,BET,SLP,ALAT,QUP,AUP,QE,QLAT,
     & AREA,A1(10),B1(10)
C
C
      ENTRY  DATA1
C
C
C
C
C     INPUT AND OUTPUT TITLE
C
 100  READ 112, ( ITITLE(N), N=1,20 )
      PRINT 212
      PRINT 113,( ITITLE(N), N=1,20 )
C
C     INPUT AND OUTPUT GENERAL INFORMATION
C
      READ 114, NOV,NDITCH,NCULVT,NDX,NSTOM,IMAX,MM
      PRINT 214
      PRINT 115, NOV,NDITCH,NCULVT,NDX,NSTOM,IMAX,MM
      NSEG=NOV+NDITCH+NCULVT
      READ 121, EPS,DT,SNU,IPD,ISV1,ISV2
      PRINT 104, EPS,DT,SNU,IPD
C
C
C
C     INPUT AND OUTPUT COMPUTATION SEQUENCE
C
      READ 118, ( ISEG(I),( IUP(I,J),J=1,3 ),
     &          ( ILAT(I,J),J=1,2 ),ITYP(I), I=1,NSEG )
```

```
      PRINT 218
      PRINT 119, ( ISEG(I),( IUP(I,J),J=1,3 ),
     &          ( ILAT(I,J),J=1,2 ),ITYP(I), I=1,NSEG )
C
C     INPUT AND OUTPUT BASIN CHARACTERISTICS AND GEOMETRY DATA           DAT  360
C                                                                        DAT  370
      READ 116, (( IDSEG(N,I),N=1,2 ),
     &          SLEN(I),SLOP1(I),PERM(I),ALPHA(I),
     &          GC(I),CN(I),PMC(I),AMC(I), I=1,NSEG )
      PRINT 216
      PRINT 117, ( I,( IDSEG(N,I),N=1,2 ),
     &          SLEN(I),SLOP1(I),PERM(I),ALPHA(I),
     &          GC(I),CN(I),PMC(I),AMC(I), I=1,NSEG )
      READ 124,  Z,DIA,DEMAX,GCI,CNI
      PRINT 105,  Z,DIA,DEMAX,GCI,CNI
C                                                                        DAT  450
C     INPUT AND OUTPUT FLOW RESISTANCE PARAMETERS                        DAT  460
C                                                                        DAT  470
      READ 107, FKL,COEFN                                                DAT  480
      PRINT 108, FKL,COEFN                                               DAT  490
      READ 120, (A1(I),B1(I),OFL(I),OFH(I),I=1,NSEG)                     DAT  500
      PRINT 220
      PRINT 122, (I, A1(I),B1(I),OFL(I),OFH(I),I=1,NSEG)
C                                                                        DAT  520
C     INPUT OUTPUT PARTICLE SIZE INFORMATION                             DAT  530
C                                                                        DAT  540
      PRINT 210
      DO 101 I=1,NSEG                                                    DAT  550
         READ 123, (DNB(I,J),J=1,MM)                                     DAT  560
         PRINT 109, I,(IDSEG(N,I),N=1,2),(DNB(I,J),J=1,MM)
         READ 123, (PBO(I,J),J=1,MM)                                     DAT  580
         PRINT 110, I,(IDSEG(N,I),N=1,2),(PBO(I,J),J=1,MM)
  101 CONTINUE                                                           DAT  600
C                                                                        DAT  610
C     INPUT AND OUTPUT SEDIMENT ROUTING PARAMETERS                       DAT  620
C                                                                        DAT  630
      READ 124, AIM,BIM,AGB,BEX,DELTS                                    DAT  640
      PRINT 224
      PRINT 125, AIM,BIM,AGB,BEX,DELTS                                   DAT  650
      READ 124, (ADF(I),I=1,NSEG)                                        DAT  660
      PRINT 211, ( I,I=1,NSEG )
      PRINT 111, (ADF(I),I=1,NSEG)                                       DAT  670
C                                                                        DAT  680
C     INPUT  AND OUTPUT RAINFALL RECORDS                                 DAT  690
C                                                                        DAT  700
      READ 126, ((ISTORM(N,I),N=1,2),ITMAX(I),ITCOM(I),I=1,NSTOM)
      DO 102 I=1,NSTOM                                                   DAT  720
         K=ITMAX(I)                                                      DAT  730
         READ 123, (DR(I,J),J=1,K)                                      DAT  740
  102 CONTINUE                                                          DAT  750
      DO 103 I=1,NSTOM                                                  DAT  760
         K=ITMAX(I)                                                     DAT  765
         PRINT 127, (ISTORM(N,I),N=1,2),ITMAX(I),ITCOM(I)
         PRINT 128                                                      DAT  780
         PRINT 129, (DR(I,J),J=1,K)                                     DAT  785
  103 CONTINUE                                                          DAT  790
C
C  SAVE SEDIMENT CHARACTERISTICS FOR PLOTTING
C
      IF( ISV1 .EQ. 0 )  GOTO 303
        WRITE( ISV1,310)  NSEG,MM,IPD,NSTOM,(ITCOM(I),I=1,NSTOM)
        DO 203  I=1,NSEG
          WRITE( ISV1,209)  (DNB(I,J),J=1,MM)
          WRITE( ISV1,209)  (PBO(I,J),J=1,MM)
 203  CONTINUE
 303  RETURN
C                                                                       DAT  810
 104  FORMAT(
     & /12X'CONVERGENCE CRITERION ='F10.3,17X'( EPS )'
     & /12X'TIME INCREMENT ='F10.3'  MINUTES'15X'( DT   )'
     & /12X'KINEMATIC VISCOSITY ='F10.3'  SQ.FT / SEC'6X'( SNU )'
     & /12X'PARTICLE DISTRIBUTIONS DISPLAYED EVERY'I3' TIME-STEPS' /)
 105  FORMAT(
     & /12X'SIDE SLOPE OF DITCH ='F10.3'  FT.  H:V'9X'( Z      )'
     & /12X'DIAMETER OF CULVERT ='F10.3'  FT.'14X'( DIA    )'
     & /12X'MAXIMUM DEPTH OF DITCH ='F10.3'  FT.'11X'( DEMAX )'
     & /12X'VOL OF INTER BY GROUND COVER ='F10.3'  CU.IN'3X'( GCI   )'
     & /12X'VOL OF INTER BY CANOPY COVER ='F10.3'  CU.IN'3X'( CNI   )'/)
  107 FORMAT (2F10.3)                                                   DAT  880
 108  FORMAT( /10X'FLOW RESISTANCE PARAMETERS'
     & /16X'FKL'9X'COEFN'
     & /10X,2F12.5 /)
 109  FORMAT( 12X'PARTICLE SIZE CLASSES (MM.) IN SEGMENT-#'I3' -- '2A4,
     & 5X'( DNB(I,J) )'
     & /10X,14F8.5 /)
 209  FORMAT( 10F8.5 )
 110  FORMAT( 12X'CUMMULATIVE DISTRIBUTION IN SEGMENT-#'I3' -- '2A4,
     & 8X'( PBO(I,J) )'
     & /10X,14F8.5 /)
 210  FORMAT( /10X'CHARACTERISTICS OF AVAILABLE SEDIMENT' )
 310  FORMAT(
     &  'TRANSPORTED SEDIMENT CHARACTERISTICS PER SEGMENT'
     & /'PERCENT FINER DISTRIBUTION .VS. PARTICLE SIZE    '
     & /4I10
     & /(8I10) )
 111  FORMAT( 10X,10F8.5 )
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```
211   FORMAT( /10X'RUNOFF DETACHMENT COEFFICIENTS'
     & /12X'ADF.'10( I1,3X'ADF.' ))
112   FORMAT( 20A4 )
212   FORMAT( 1H1,5/10X'GENERAL WATERSHED MODELING CONDITIONS' )
113   FORMAT( 10X,20A4 )
 114  FORMAT (7I10)                                                   DAT  950
214   FORMAT( 17X'NOV'5X'NDITCH'4X'NCULVT'6X'NDX'
     & 5X'NSTOM'6X'IMAX'8X'MM' )
 115  FORMAT (10X,7I10/)                                              DAT  960
116   FORMAT( 2X,2A4,8F8.3 )
216   FORMAT(
     & /10X'BASIN CHARACTERISTICS AND GEOMETRY'
     & /11X'NSEG'6X'IDSFG'7X'SLEN'5X'SLOP1'6X'PERM'5X'ALPHA'
     & 8X'GC'6X'CN'7X'PMC'7X'AMC' )
117   FORMAT( 10X,I5,5X,2A4,8F10.3 )
 118  FORMAT (7I10)                                                   DAT  990
218   FORMAT(
     & /10X'COMPUTATION SEQUENCE AND RESPONSE UNITS'
     & /16X'ISEG'5X'IUP.1'5X'IUP.2'5X'IUP.3'4X
     & 'ILAT.1'4X'ILAT.2'6X'ITYP' )
119   FORMAT( 10X,7I10 )
 120  FORMAT (4F10.3)                                                 DAT 1010
220   FORMAT(
     & /10X'CHANNEL CHARATERISTICS AND FLOW RESISTANCE'
     & /11X'NSEG'6X'A1'10X'B1'10X'OFL'9X'OFH' )
 121  FORMAT (2F10.3,E10.3,3I10)
122   FORMAT( 10X,I5,4F12.5 /)
 123  FORMAT (10F8.3)                                                 DAT 1050
 124  FORMAT (5F10.3)                                                 DAT 1060
224   FORMAT(
     & /10X'SEDIMENT ROUTING PARAMETERS'
     & /16X'AIM'9X'BIM'9X'AGB'9X'BEX'9X'DELTS' )
125   FORMAT( 10X,5F12.5 )
126   FORMAT( 2X,2A4,2I10 )
127   FORMAT( /10X'RAINFALL SIMULATION'
     & /12X'STORM ID. : '2A4,16X'( TSTORM )'
     & /12X'RAINFALL DURATION ='I4'  INCR.'6X'( ITMAX  )'
     & /12X'RUNOFF DURATION ='I4'  INCR.'8X'( ITCOM  )' /)
128   FORMAT( /10X'RAINFALL INTENSITY  PER TIME INCREMENT'
     & /15X'TE:    54.321  IN./HR.'9X'( DR(I,J) )' )
129   FORMAT( 10X,12F8.3 )
C                                                                     DAT 1120
      END                                                             DAT 1130
```

```
C*
      SUBROUTINE PERTG (K)
C
      DIMENSION ZB(100)
C
      COMMON /VAR1/  NSEG,NDX,NSTOM,IMAX,MM,
     & IPD,IPD1,ISV1,ISV2
      COMMON /VAR2/  IDSEG(2,10),SLEN(10),SLOP1(10),PERM(10),
     & ALPHA(10),CF(200,10),DMB(10,15),PBO(10,15),GC(10),Z,DIA,DEMAX,
     & DB4(10),SSUM,PMC(10),AMC(10),CN(10),GCI,CNI,
     & SINT(10),DNB(10,15)
CX    COMMON /VAR3/  ISEG(010),IUP(010,3),ILAT(010,2),ITYP(010)
CX    COMMON /VAR4/  ATM,BIM,AGB,BEX,ADF(10),DELTS
CX    COMMON /VAR5/  FKL,OFL(10),OFH(10),COEFN,SNU,GRF,ERF
CX    COMMON /VAR6/  ISTORM(2,05),ITMAX(05),ITCOM(05),DR(05,200),
CX   & RCUM(10),RRNET(10),RPEXC(10)
      COMMON /VAR7/  EGB(15),GBC(15),ZBL(15),GBUP(15),GBLAT(15),
     & BLAT(15),BTEM(15),SB(10,10,15),RB(10,10,15),
     & SLOP(10,10),DDEP(15)
      COMMON /VAR8/  A(10,10),Q(100),QP(10,10),PB1(10,15),GBO(10,15)
      COMMON /VAR9/  PORB(15),ZSUM,ASUM,EPS,DT
CX    COMMON /VAR10/  CPR,EPR,ALP,BET,SLP,ALAT,QUP,AUP,QE,QLAT,
CX   & AREA,A1(10),B1(10)
C
C
C     ENTRY  PERTG( K )
C
 100  SSUM=0.
      DO 101 M=1,MM
         ZB(M)=ZBL(M)
         SSUM=SSUM+ZB(M)
  101 CONTINUE
      SUM=SSUM
      SSSUM=PORB(K)*DB4(K)
      IF (SSUM.GT.SSSUM) GO TO 103
      GDIFR=SSSUM-SSUM
      DO 102 M=1,MM
         ZB(M)=ZB(M)+PBO(K,M)*GDIFR
  102 CONTINUE
      SUM=SSSUM
  103 CONTINUE
      DO 104 M=1,MM
         PB1(K,M)=ZB(M)/SUM
  104 CONTINUE
      RETURN
C
      END
```

```
C*
      SUBROUTINE  TRANS (K,J,BPER)
C
      COMMON /VAR1/  NSEG,NDX,NSTOM,IMAX,MM,
     & IPD,IPD1,ISV1,ISV2
      COMMON /VAR2/  IDSEG(2,10),SLEN(10),SLOP1(10),PERM(10),
     & ALPHA(10),CF(200,10),DMB(10,15),PBO(10,15),GC(10),Z,DIA,DEMAX,
     & D84(10),SSUM,PMC(10),AMC(10),CN(10),GCI,CNI,
     & SINT(10),DNB(10,15)
      COMMON /VAR3/  ISEG(010),IUP(010,3),ILAT(010,2),ITYP(010)
      COMMON /VAR4/  ATM,BIM,AGB,BEX,ADF(10),DELTS
      COMMON /VAR5/  FKL,OFL(10),OFH(10),COEFN,SNU,GRF,ERF
CX    COMMON /VAR6/  ISTORM(2,05),ITMAX(05),TTCOM(05),DR(05,200),
CX   & RCUM(10),RRNET(10),RREXC(10)
      COMMON /VAR7/  EGB(15),GBC(15),ZBL(15),GBUP(15),GBLAT(15),
     & BLAT(15),BTEM(15),SB(10,10,15),RB(10,10,15),
     & SLOP(10,10),DDEP(15)
      COMMON /VAR8/  A(10,10),Q(100),QP(10,10),PB1(10,15),GBO(10,15)
      COMMON /VAR9/  POR3(15),ZSUM,ASUM,EPS,DT
      COMMON /VAR10/  CPR,EPR,ALP,BET,SLP,ALAT,QUP,AUP,QE,QLAT,
     & AREA,A1(10),B1(10)
C
C
C     ENTRY  TRANS( K,J,BPER )
C
C
C     DETERMINATION OF FLOW CONDITIONS, SUCH AS HYDRAULIC DEPTH, MEAN
C     VELOCITY, AND BOUNDARY SHEAR STRESS
C
 100  GOTO( 103,110,101 ), ITYP(K)
  101 CONTINUE
      AREA=ALP*QE**BET
      WEPER=CPR*AREA**EPR
      BPER=WEPER
      HYRAD=AREA/WEPER
      VMEAN=QE/AREA
C
C     COMPUTE THE TRANSPORTING CAPACITY OF CUVLERT
C
      DO 102 M=1,MM
          GBC(M)=21.44*DMB(K,M)**(-1.02)*SLP**2.52
     &             *(AREA/BPER)**(1.52)*AREA
          RB(K,J,M)=GBC(M)*PB1(K,M)/QE
  102 CONTINUE
      RETURN
C
C     COMPUTE THE TRANSPORTING CAPACITY OF OVERLAND FLOW UNITS
C
```

```
  103 CONTINUE
      AREA=ALP*QE**BET
      WEPER=CPP*AREA**EPR
      HYRAD=AREA/WEPER
      BPER=WEPER
      RN=QE/(SNU*WEPER)
      VMEAN=QE/AREA
      TAU=62.4*HYRAD*SLP
      SV=SQRT(TAU/1.9379)
      BMV=2.5+VMEAN/SV
      TAO=0.24224*(GRF/RN**ERF)*VMEAN*VMEAN
      DO 109 M=1,MM
         TTEM=TAO-102.96*DELTS*DMB(K,M)
C
C     BED MATERIAL LOAD ROUTING
C
         IF (TTEM.LE.0.) GO TO 108
C
C     DETERMINATION OF RATIO OF SUSPENDED BED MATERIAL LOAD
C
         IF (DMB(K,M).GT.0.0002) GO TO 104
         FVB=2.9517*DMB(K,M)**2/SNU
         GO TO 105
  104    CONTINUE
         FVB=(SQRT(36.064*DMB(K,M)**3+36.*SNU**2)-6.*SNU)/DMB(K,M)
  105    ZR=FVB/(0.4*SV)
         AR=2.*DMB(K,M)/HYRAD
         IF (AR.GT.0.9) GO TO 106
         CALL POWER (ZR,AR,FJ,SJ,1.0E-2)
         P=AR**(ZR-1.)/(11.6*(1.-AR)**ZR)
         SUSP=P*(BMV*FJ+2.5*SJ)
         IF (SUSP.LT.0.) SUSP=0.
         GO TO 107
  106    SUSP=0.
C
C     DETERMINAITON OF TRANSPORTING CAPACITY OF BED MATERIAL LOAD
C
  107    GBC(M)=(1+SUSP)*WEPER*AGB*TTEM**BEX
         RB(K,J,M)=GBC(M)*PB1(K,M)/QE
         GO TO 109
  108    RB(K,J,M)=0.
  109 CONTINUE
      RETURN
C
C     COMPUTE THE TRANSPORTING CAPACITY OF DITCH
C
  110 CONTINUE
      AREA=ALP*QE**BET
      DEPTH=SQRT(AREA/Z)
      WEPER=DEPTH*SQRT(1+Z*Z)*2.
      BPER=WEPER
      HYRAD=Z/(2.*SQRT(1.+Z*Z))*DEPTH
      VMEAN=QE/AREA
      TAO=0.24225*GRF*VMEAN*VMEAN/(QE*HYRAD/(SNU*AREA))**ERF
      DO 117 M=1,MM
         SV=SQRT(62.4*HYRAD*SLP/1.938)
         IF (DMB(K,M).GT.0.0002) GO TO 111
         FVB=2.9517*DMB(K,M)**2/SNU
         GO TO 112
  111    CONTINUE
         FVB=(SQRT(36.064*DMB(K,M)**3+36.*SNU**2)-6.*SNU)/DMB(K,M)
  112    CONTINUE
         ZR=FVB/(0.4*SV)
         AR=2.*DMB(K,M)/HYRAD
         BMV=2.5+VMEAN/SV
         IF (AR.GT.0.9) GO TO 113
         CALL POWER (ZR,AR,FJ,SJ,1.0E-2)
         P=AR**(ZR-1.)/(11.6*(1.-AR)**ZR)
         SUSP=P*(BMV*FJ+2.5*SJ)
         IF (SUSP.LT.0.) SUSP=0.
         GO TO 114
  113    SUSP=0.
  114    CONTINUE
         TAOC=102.96*DELTS*DMB(K,M)
         IF (TAO.GT.TAOC) GO TO 115
         SEDD=0.
         SUSP=0.
         GO TO 116
  115    SEDD=AGB*(TAO-TAOC)**1.5
  116    SEDQ=(1.+SUSP)*SEDD
         SEDQ=SEDQ*Z*DEPTH*2.
         GBC(M)=SEDQ
         PB(K,J,M)=GBC(M)*PB1(K,M)/QE
  117 CONTINUE
C
      END
```

```
C*
      SUBROUTINE FRICT (K)                                              FRI   10
C
CX     COMMON /VAR1/  NSEG,NDX,NSTOM,IMAX,MM,
CX    & IPD,IPD1,ISV1,ISV2
       COMMON /VAR2/  IDSEG(2,10),SLEN(10),SLOP1(10),PERM(10),
      & ALPHA(10),CF(200,10),DMB(10,15),PRO(10,15),GC(10),Z,DIA,DEMAX,
      & D84(10),SSUM,PMC(10),AMC(10),CN(10),GCI,CNI,
      & SINT(10),DNB(10,15)
       COMMON /VAR3/  ISEG(010),IUP(010,3),ILAT(010,2),ITYP(010)
       COMMON /VAR4/  ATM,BIM,AGB,BEX,ADF(10),DELTS
       COMMON /VAR5/  FKL,OFL(10),OFH(10),COEFN,SNU,GRF,ERF
CX     COMMON /VAR6/  ISTOPM(2,05),ITMAX(05),ITCOM(05),DR(05,200),
CX    & RCUM(10),RRNET(10),RREXC(10)
CX     COMMON /VAR7/  EGB(15),GBC(15),ZBL(15),GBUP(15),GBLAT(15),
CX    & BLAT(15),BTEM(15),SB(10,10,15),RB(10,10,15),
CX    & SLOP(10,10),DDEP(15)
CX     COMMON /VAR8/  A(10,10),Q(100),QP(10,10),PB1(10,15),GBO(10,15)
CX     COMMON /VAR9/  PORB(15),ZSUM,ASUM,EPS,DT
       COMMON /VAR10/  CPR,EPR,ALP,BET,SLP,ALAT,QUP,AUP,QE,QLAT,
      & AREA,A1(10),B1(10)
C
C
C      ENTRY  FRICT( K )
C
C                                                                       FRI  100
C      THIS SUBROUTINE DETERMINES THE COEFFICIENT AND
C         THE EXPONENT IN A-Q RELATION
C                                                                       FRI  130
 100   ERF=1.
       GRF=FKL                                                          FRI  150
       CRF=OFL(K)+(OFH(K)-OFL(K))*GC(K)*GC(K)                           FRI  160
       AEXP=1./(3.-EPR*(1.+ERF))                                        FRI  170
       ALP=((CPR**(1.+ERF)*CRF*SNU**ERF/(257.6*SLP))**AEXP              FRI  180
       BET=(2.-ERF)*AEXP                                                FRI  190
C                                                                       FRI  200
       RETURN                                                           FRI  210
C                                                                       FRI  220
       END                                                              FRI  230
```

```
C*
      SUBROUTINE UPLAT (K,DTS,RNET)
C
      COMMON /VAR1/  NSEG,NDX,NSTOM,IMAX,MM,
     & IPD,IPD1,ISV1,ISV2
CX    COMMON /VAR2/  IDSEG(2,10),SLEN(10),SLOP1(10),PERM(10),
CX   & ALPHA(10),CF(200,10),DMB(10,15),PBO(10,15),GC(10),Z,DIA,DEMAX,
CX   & D84(10),SSUM,PMC(10),AMC(10),CN(10),GCI,CNT,
CX   & SINT(10),DNB(10,15)
      COMMON /VAR3/  ISEG(010),IUP(010,3),ILAT(010,2),ITYP(010)
CX    COMMON /VAR4/  AIM,BIM,AGB,BEX,ADF(10),DELTS
CX    COMMON /VAR5/  FKL,OFL(10),OFH(10),COEFN,SNU,GRF,ERF
CX    COMMON /VAR6/  ISTORM(2,05),TTMAX(05),ITCUM(05),DR(05,200),
CX   & RCUM(10),RRNET(10),RREXC(10)
      COMMON /VAR7/  EGB(15),GBC(15),ZBL(15),GBUP(15),GBLAT(15),
     & BLAT(15),BTEM(15),SB(10,10,15),RB(10,10,15),
     & SLOP(10,10),DDEP(15)
      COMMON /VAR8/  A(10,10),Q(100),QP(10,10),PB1(10,15),GBO(10,15)
      COMMON /VAR9/  PORB(15),ZSUM,ASUM,EPS,DT
      COMMON /VAR10/  CPR,EPR,ALP,BET,SLP,ALAT,QUP,AUP,QE,QLAT,
     & AREA,A1(10),B1(10)
C
C
C     ENTRY  UPLAT( K,DTS,RNET )
C
C
 100  AUP=0.
      QUP=0.
      QLAT=0.
      ALAT=0.
C
C     DETERMINE THE UPSTREAM INFLOW RATE
C
      DO 101 I=1,MM
         BLAT(I)=0.
         GBUP(I)=0.
         GBLAT(I)=0.
  101 CONTINUE
      DO 103 J=1,3
         IF (IUP(K,J).EQ.0) GO TO 103
         JJ=IUP(K,J)
         QUP=QUP+Q(JJ)
         DO 102 M=1,MM
            GBUP(M)=GBUP(M)+GBO(JJ,M)
  102    CONTINUE
  103 CONTINUE
      IF (ITYP(K).GT.1) GO TO 104
      QLAT=QLAT+CPR*RNET/43200.
  104 CONTINUE
```

```
C
C     DETERMINE THE LATERAL INFLOW RATE
C
      IF (ITYP(K).GT.2) RETURN
      DO 106 J=1,2
         IF (ILAT(K,J).EQ.0) GO TO 106
         JJ=ILAT(K,J)
         QLAT=QLAT+Q(JJ)
         DO 105 I=1,MM
            GBLAT(I)=GBLAT(I)+GBO(JJ,I)
            BLAT(I)=GBLAT(I)*DTS
  105    CONTINUE
  106 CONTINUE
C
      RETURN
C
      END
```

```
C*
      SUBROUTINE WROUT (K,J,DTX)
C
      COMMON /VAR1/  NSEG,NDX,NSTOM,IMAX,MM,
     & IPD,IPD1,ISV1,ISV2
CX    COMMON /VAR2/  IDSEG(2,10),SLEN(10),SLOP1(10),PERM(10),
CX   & ALPHA(10),CF(200,10),DMB(10,15),PBO(10,15),GC(10),Z,DIA,DEMAX,
CX   & D84(10),SSUM,PMC(10),AMC(10),CN(10),GCT,CNI,
CX   & SINT(10),DNB(10,15)
CX    COMMON /VAR3/  ISEG(010),IUP(010,3),ILAT(010,2),ITYP(010)
CX    COMMON /VAR4/  ATM,BTM,AGB,BEX,ADF(10),DELTS
CX    COMMON /VAR5/  FKL,DFL(10),DFH(10),COEFN,SNU,GRF,ERF
CX    COMMON /VAR6/  ISTORM(2,05),ITMAX(05),ITCOM(05),DR(05,200),
CX   & RCUM(10),RRNET(10),RREXC(10)
      COMMON /VAR7/  EGB(15),GBC(15),ZBL(15),GBUP(15),GBLAT(15),
     & BLAT(15),BTEM(15),SB(10,10,15),RB(10,10,15),
     & SLOP(10,10),DDEP(15)
      COMMON /VAR8/  A(10,10),Q(100),QP(10,10),PB1(10,15),GBO(10,15)
      COMMON /VAR9/  PORB(15),ZSUM,ASUM,EPS,DT
      COMMON /VAR10/  CPR,EPR,ALP,BET,SLP,ALAT,QUP,AUP,QF,QLAT,
     & AREA,A1(10),B1(10)
C
C
C     ENTRY  WROUT( K,J,DTX )
C
C
C     SET UP A-Q RELATIONSHIP
C
 100  QPRX=QP(K,J)
      QAVE=0.5*(QUP+QPRX)
      BEM=BET-1.
      BEN=BEM-1.
      ALBET=ALP*BET
      ALBEM=ALP*BET*BEM
      DTXA=DTX+ALP
      ERROR=EPS*ASUM
C
C     LINEAR SCHEME TO FIND THE FIRST APPROXIMATION
C
      ITER=0
      IF (QAVE.LE.1.0E-5) GO TO 101
      DAQ=ALBET*QAVE**BEM
      QF=(ALAT+DTX*QUP+DAQ*QPRX)/(DTX+DAQ)
      GO TO 102
  101 QF=ASUM/DTXA
C
C     NONLINEAR SCHEME TO REFINE THE SOLUTION
C
```

```
 102  ITER=ITER+1                                                       WRO  310
      AEST=DTX*QE+ALP*QE**BET                                           WRO  320
      ADEV=ASUM-AEST                                                    WRO  330
      IF (ABS(ADEV).LE.ERROR) GO TO 107                                 WRO  340
      IF (ITER.LT.IMAX) GO TO 103                                       WRO  350
      STOP                                                              WRO  360
 103  FDER=DTX+ALBET*QE**BEM                                            WRO  370
      SDER=ALBEM*QE**BEN                                                WRO  380
      BB=FDER/SDER                                                      WRO  390
      SC=2.*ADEV/SDER                                                   WRO  400
      STEM=BB*BB+SC                                                     WRO  410
      IF (STEM.GE.0.) GO TO 104                                         WRO  420
      QE=QE+ADEV/FDER                                                   WRO  430
      GO TO 102                                                         WRO  440
 104  STEM=SQRT(STEM)                                                   WRO  450
      IF (ADEV.GT.0.) GO TO 106                                         WRO  460
      ETEM=BB+STEM                                                      WRO  470
      QE=QE-ETEM                                                        WRO  480
      IF (QE.GT.0.) GO TO 102                                           WRO  490
 105  ETEM=0.5*ETEM                                                     WRO  500
      QE=QE+ETEM                                                        WRO  510
      IF (QE.GT.0.) GO TO 102                                           WRO  520
      GO TO 105                                                         WRO  530
 106  X1=QE-BB-STEM                                                     WRO  540
      X2=QE-BB+STEM                                                     WRO  550
      AD1=ABS(ASUM-DTX*X1-ALP*X1**BET)                                  WRO  560
      AD2=ABS(ASUM-DTX*X2-ALP*X2**BET)                                  WRO  570
      QE=X1                                                             WRO  580
      IF (AD1.GT.AD2) QE=X2                                             WRO  590
      GO TO 102                                                         WRO  600
 107  RETURN                                                            WRO  610
C                                                                       WRO  620
C                                                                       WRO  630
      END                                                               WRO  640
```

```
C*
      SUBROUTINE SROUT (K,J,DTX,BPER)
C
      COMMON /VAR1/  NSEG,NDX,NSTOM,IMAX,MM,
     & IPD,IPD1,ISV1,ISV2
      COMMON /VAR2/  IDSEG(2,10),SLEN(10),SLOP1(10),PERM(10),
     & ALPHA(10),CF(200,10),DMB(10,15),PBO(10,15),GC(10),Z,DIA,DEMAX,
     & D84(10),SSUM,PMC(10),AMC(10),CN(10),GCI,CNI,
     & SINT(10),DNB(10,15)
CX    COMMON /VAR3/  ISEG(010),IUP(010,3),ILAT(010,2),ITYP(010)
      COMMON /VAR4/  ATM,BIM,AGB,BEX,ADF(10),DELTS
      COMMON /VAR5/  FKL,OFL(10),OFH(10),COEFN,SNU,GRF,ERF
CX    COMMON /VAR6/  ISTORM(2,05),ITMAX(05),ITCOM(05),DR(05,200),
CX   & RCUM(10),RRNET(10),RREXC(10)
      COMMON /VAR7/  EGB(15),GBC(15),ZBL(15),GBUP(15),GBLAT(15),
     & BLAT(15),BTEM(15),SB(10,10,15),RB(10,10,15),
     & SLOP(10,10),DDEP(15)
      COMMON /VAR8/  A(10,10),Q(100),QP(10,10),PB1(10,15),GBO(10,15)
      COMMON /VAR9/  PORB(15),ZSUM,ASUM,EPS,DT
      COMMON /VAR10/  CPR,EPR,ALP,BET,SLP,ALAT,QUP,AUP,QE,QLAT,
     & AREA,A1(10),B1(10)
C
C
C     ENTRY  SROUT( K,J,DTX,BPER )
C
 100  SGBUP=0.
      SRBE=0.
      SBTEM=0.
      SBLAT=0.
C
C     CHECK THE AVAILABILITY OF BED MATERIAL LOAD
C
      DO 101 M=1,MM
         SGBUP=SGBUP+GBUP(M)
         SRBE=SRBE+RB(K,J,M)
         SBTEM=SBTEM+BTEM(M)
  101 SBLAT=SBLAT+BLAT(M)
      SEGB=(SGBUP-SRBE*QE)*DTX-SRBE*AREA+SBTEM*A(K,J)+SBLAT
      IF (SEGB.GE.0.) GO TO 102
      EBTEM=SEGB+SSUM*BPER
      IF (EBTEM.GE.0.) GO TO 102
      DEP=-ADF(K)*EBTEM/BPER
      GO TO 103
  102 DEP=0.
  103 CONTINUE
      DO 104 M=1,MM
         ZBL(M)=ZBL(M)+DEP*PBO(K,M)
  104 CONTINUE
```

```
      DO 105 M=1,MM                                                     SRO  370
         EGB(M)=(GBUP(M)-RB(K,J,M)*QE)*DTX-RB(K,J,M)*AREA
     &             +BTEM(M)*A(K,J)+BLAT(M)
         IF (EGB(M).GE.0.) GO TO 105                                    SRO  400
         EBTEM=EGB(M)+ZBL(M)*BPER                                       SRO  410
         IF (EBTEM.GE.0.) GO TO 105                                     SRO  420
         RB(K,J,M)=(ZBL(M)*BPER+BLAT(M)+BTEM(M)*A(K,J)+GBUP(M)*DTX)
     &                  /(AREA+QE*DTX)
         IF (RB(K,J,M).LE.0.) RB(K,J,M)=0.                              SRO  450
         EGB(M)=-ZBL(M)*BPER                                            SRO  460
  105 CONTINUE                                                          SRO  470
      RETURN                                                            SRO  480
C                                                                       SRO  490
C                                                                       SRO  500
      END                                                               SRO  510
```

```
C*
      SUBROUTINE POWER (Z,A,XJ1,XJ2,CONV)
C
C     THIS SUBROUTINE EVALUATES J1 AND J2 INTEGRALS
C         NOTATION:
C           XJ1 = VALUE OF J1 INTEGRAL
C           XJ2 = VALUE OF J2 INTEGRAL
C           N = ORDER OF APPROXIMATION + 1
C           CONV = CONVERGENCE CRITERION
C
C
C     ENTRY  POWER( Z,A,XJ1,XJ2,CONV )
C
 100  N=1
      XJ1=0.
      XJ2=0.
      ALG=ALOG(A)
      C=1.
      D=-Z
      E=D+1.
      FN=1.
      AEX=A**E
      GO TO 102
  101 N=N+1
      C=C*D/FN
      D=E
      E=D+1.
      FN=FLOAT(N)
      AEX=A**E
  102 IF (ABS(E).LE.0.001) GO TO 103
      XJ1=XJ1+C*(1.-AEX)/E
      XJ2=XJ2+C*((AEX-1.)/E**2-AEX*ALG/E)
      GO TO 104
  103 XJ1=XJ1-C*ALG
      XJ2=XJ2-0.5*C*ALG**2
  104 IF (N.EQ.1) GO TO 105
      CJ1=ABS(1.-FJ1/XJ1)
      CJ2=ABS(1.-FJ2/XJ2)
      IF (CJ1.LE.CONV.AND.CJ2.LE.CONV) RETURN
  105 FJ1=XJ1
      FJ2=XJ2
      GO TO 101
C
      END
```

```
C*
      SUBROUTINE CEASE (K,J,DTX)
C
      COMMON /VAR1/  NSEG,NDX,NSTOM,IMAX,MM,
     & IPD,IPD1,ISV1,ISV2
CX    COMMON /VAR2/  IDSEG(2,10),SLEN(10),SLOP1(10),PERM(10),
CX   & ALPHA(10),CF(200,10),DMB(10,15),PBO(10,15),GC(10),Z,DIA,DEMAX,
CX   & DB4(10),SSUM,PMC(10),AMC(10),CN(10),GCI,CNI,
CX   & SINT(10),DNB(10,15)
      COMMON /VAR3/  ISEG(010),IUP(010,3),ILAT(010,2),ITYP(010)
      COMMON /VAR4/  ATM,BIM,AGB,REX,ADF(10),DELTS
CX    COMMON /VAR5/  FKL,OFL(10),OFH(10),COEFN,SNU,GRF,ERF
CX    COMMON /VAR6/  ISTORM(2,05),ITMAX(05),ITCUM(05),DR(05,200),
CX   & RCUM(10),RRNET(10),RREXC(10)
      COMMON /VAR7/  EGB(15),GBC(15),ZBL(15),GBUP(15),GBLAT(15),
     & BLAT(15),BTEM(15),SB(10,10,15),RB(10,10,15),
     & SLOP(10,10),DDEP(15)
      COMMON /VAR8/  A(10,10),Q(100),QP(10,10),PB1(10,15),GBO(10,15)
      COMMON /VAR9/  PORB(15),ZSUM,ASUM,EPS,DT
      COMMON /VAR10/  CPR,EPR,ALP,BET,SLP,ALAT,QUP,AUP,QE,QLAT,
     & AREA,A1(10),B1(10)
C
C
C     ENTRY  CEASE( K,J,DTX )
C
 100  IF( ITYP(K) .LT. 2 )  GOTO 102
      QE=QUP
      AREA=AUP
      IF (QE.EQ.0.) GO TO 102
      DO 101 M=1,MM
         RB(K,J,M)=GBUP(M)/QE
         EGB(M)=GBUP(M)*DTX+BTEM(M)*A(K,J)+BLAT(M)
  101 CONTINUE
      RETURN
  102 AREA=0.
      QE=0.
      DO 103 M=1,MM
         EGB(M)=GBUP(M)*DTX+BTEM(M)*A(K,J)+BLAT(M)
  103 RB(K,J,M)=0.
      RETURN
C
      END
```

```
C*
      SUBROUTINE CULVT (K)                                              CUL   10
C
CX    COMMON /VAR1/  NSEG,NDX,NSTOM,IMAX,MM,
CX   & IPD,IPD1,ISV1,ISV2
      COMMON /VAR2/  IDSEG(2,10),SLEN(10),SLOP1(10),PERM(10),
     & ALPHA(10),CF(200,10),DMB(10,15),PBO(10,15),GC(10),Z,DIA,DEMAX,
     & DB4(10),SSUM,PMC(10),AMC(10),CN(10),GCI,CNI,
     & SINT(10),DNB(10,15)
      COMMON /VAR3/  ISEG(010),IUP(010,3),ILAT(010,2),ITYP(010)
CX    COMMON /VAR4/  AIM,BIM,AGB,BEX,ADF(10),DELTS
      COMMON /VAR5/  FKL,OFL(10),OFH(10),COEFN,SNU,GRF,FRF
CX    COMMON /VAR6/  ISTORM(2,05),ITMAX(05),ITCOM(05),DR(05,200),
CX   & RCUM(10),RRNET(10),RREXC(10)
CX    COMMON /VAR7/  EGB(15),GBC(15),ZBL(15),GBUP(15),GBLAT(15),
CX   & BLAT(15),BTEM(15),SB(10,10,15),RB(10,10,15),
CX   & SLOP(10,10),DDEP(15)
CX    COMMON /VAR8/  A(10,10),Q(100),QP(10,10),PB1(10,15),GBO(10,15)
      COMMON /VAR9/  PORB(15),ZSUM,ASUM,EPS,DT
      COMMON /VAR10/  CPR,EPR,ALP,BET,SLP,ALAT,QUP,AUP,QE,QLAT,
     & AREA,A1(10),B1(10)
C
C
C     ENTRY  CULVT( K )
C
 100  QE=QUP
      XC1=QE*COEFN/(1.486*SLP**0.5)                                     CUL  110
      XC1=XC1/DIA**(8./3.)                                              CUL  120
      XYX=XC1                                                           CUL  130
      XY1=0.8136*XYX**0.4104                                            CUL  140
      IF (XY1.GT.0.24) GO TO 101                                        CUL  150
      CPR=1.9751*DIA**0.305                                             CUL  160
      EPR=0.3475                                                        CUL  170
      RETURN                                                            CUL  180
  101 XY1=1.4*XYX**0.55                                                 CUL  190
      IF (XY1.GT.0.68) GO TO 102                                        CUL  200
      CPR=2.478*DIA**0.0462                                             CUL  210
      EPR=0.4769                                                        CUL  220
      RETURN                                                            CUL  230
  102 XY1=3.1*XYX**1.12                                                 CUL  240
      IF (XY1.GT.0.94) GO TO 103                                        CUL  250
      CPR=3.43*DIA**(-1.156)                                            CUL  260
      EPR=1.078                                                         CUL  270
      RETURN                                                            CUL  280
  103 CPR=2.*SQRT(3.1416)                                               CUL  290
      EPR=0.5                                                           CUL  300
      RETURN                                                            CUL  310
C                                                                       CUL  320
```

```
C*
      SUBROUTINE  AGGDG (K,IFLAG)
C
      COMMON /VAR1/  NSEG,NDX,NSTOM,IMAX,MM,
     & IPD,IPD1,ISV1,ISV2
      COMMON /VAR2/  IDSEG(2,10),SLEN(10),SLOP1(10),PERM(10),
     & ALPHA(10),CF(200,10),DMB(10,15),PBO(10,15),GC(10),Z,DIA,DEMAX,
     & D84(10),SSUM,PMC(10),AMC(10),CN(10),GCI,CNI,
     & SINT(10),DNB(10,15)
      COMMON /VAR3/  ISEG(010),IUP(010,3),ILAT(010,2),ITYP(010)
CX    COMMON /VAR4/  AIM,BIM,AGB,BEX,ADF(10),DFLTS
      COMMON /VAR5/  FKL,OFL(10),OFH(10),COEFN,SNU,GRF,ERF
CX    COMMON /VAR6/  ISTORM(2,05),TTMAX(05),ITCOM(05),DR(05,200),
CX   & RCUM(10),RRNET(10),RREXC(10)
      COMMON /VAR7/  EGB(15),GBC(15),ZBL(15),GBUP(15),GBLAT(15),
     & BLAT(15),BTEM(15),SB(10,10,15),RB(10,10,15),
     & SLOP(10,10),DDEP(15)
CX    COMMON /VAR8/  A(10,10),Q(100),QP(10,10),PB1(10,15),GBO(10,15)
CX    COMMON /VAR9/  PORB(15),ZSUM,ASUM,EPS,DT
CX    COMMON /VAR10/  CPR,EPR,ALP,BET,SLP,ALAT,QUP,AUP,QE,QLAT,
CX   & AREA,A1(10),B1(10)
C
C
C     ENTRY  AGGDG( K,IFLAG )
C
 100  IF( ITYP(K) .EQ. 2 )  GOTO 103
      DO 101 J=1,NDX
         IF (DDEP(J).GT.DIA) GO TO 102
  101 CONTINUE
      RETURN
  102 PRINT 107, DDEP(J)
      PRINT 106
      IFLAG=1
      RETURN
  103 DO 104 J=1,NDX
         IF (DDEP(J).GT.DEMAX) GO TO 105
  104 CONTINUE
      RETURN
  105 PRINT 107, DDEP(J)
      PRINT 108
      IFLAG=1
      RETURN
C
  106 FORMAT (10X,61HTHE AGGREDATION DEPTH IS GREATER THAN THE DIAMETER
     1OF CULVERT/)
  107 FORMAT (10X,E15.4/)
  108 FORMAT (10X,64HTHE AGGREDATION DEPTH IS GREATER THAN THE MAXIMUM D
     1EPTH OF DITCH/)
```

```
C*
      SUBROUTINE CAPA (K,QUP,IFLGQ,IFLGS)
C
      COMMON /VAR1/  NSEG,NDX,NSTOM,IMAX,MM,
     & TPD,IPD1,ISV1,ISV2
      COMMON /VAR2/  IDSEG(2,10),SLEN(10),SLOP1(10),PERM(10),
     & ALPHA(10),CF(200,10),DMB(10,15),PBO(10,15),GC(10),Z,DIA,DEMAX,
     & DP4(10),SSUM,PMC(10),AMC(10),CN(10),GCI,CNI,
     & SINT(10),DNB(10,15)
      COMMON /VAR3/  ISEG(010),IUP(010,3),ILAT(010,2),ITYP(010)
      COMMON /VAR4/  AIM,BIM,AGB,BEX,ADF(10),DELTS
      COMMON /VAR5/  FKL,OFL(10),OFH(10),COEFN,SNU,GRF,ERF
CX    COMMON /VAR6/  ISTORM(2,05),ITMAX(05),ITCOM(05),DR(05,200),
CX   & RCUM(10),RRNET(10),RREXC(10)
      COMMON /VAR7/  EGB(15),GBC(15),ZBL(15),GBUP(15),GBLAT(15),
     & BLAT(15),PTEM(15),SB(10,10,15),RB(10,10,15),
     & SLOP(10,10),DDEP(15)
CX    COMMON /VAR8/  A(10,10),Q(100),QP(10,10),PP1(10,15),GBO(10,15)
CX    COMMON /VAR9/  PORB(15),ZSUM,ASUM,EPS,DT
CX    COMMON /VAR10/  CPR,EPR,ALP,BET,SLP,ALAT,QUP,AUP,QE,QLAT,
CX   & AREA,A1(10),B1(10)
C
C
C     ENTRY  CAPA( K,QUP,IFLGQ,IFLGS )
C
 100  GBCCS=0.
      GBCDS=0.
      SLP=SLOP1(K)
      SGPUP=0.
C
C     COMPUTING THE TRANSPORTING CAPACITY OF CULVERT
C
      GO TO (101,103,101), ITYP(K)
  101 CONTINUE
      AREA=0.785*DIA*DIA
      HYRAD=DIA/4.
      VMEAN=1.486*AREA*HYRAD**(2./3.)*SLP/COEFN
      QEC=VMEAN*AREA
      DO 102 M=1,MM
         GBC(M)=21.44*DMB(K,M)**(-1.02)*SLP**2.52*HYRAD**1.52*AREA
         GBCCS=GBCCS+GBC(M)*PBO(K,M)
  102 CONTINUE
      GO TO 111
  103 CONTINUE
      ERF=1.0
      GRF=FKL
      CRF=OFL(K)+(OFH(K)-OFL(K))*GC(K)*GC(K)
C
```

```
C     COMPUTING TRANSPORTING CAPACITY OF DITCH
C
      AREA=Z*DEMAX*DEMAX
      WEPER=2.*DEMAX*(SQRT(1.+Z*Z))
      HYRAD=Z/(2.*SQRT(1.+Z*Z))*DEMAX
      VMEAN=257.6*SLP*HYRAD*HYRAD/(SNU*CRF)
      QED=VMEAN*AREA
      TAO=0.24225*GRF*VMEAN/(VMEAN*HYRAD/SNU)**ERF
      DO 110 M=1,MM
          SV=SQRT(62.4*HYRAD*SLP/1.938)
          IF (DMB(K,M).GT.0.0002) GO TO 104
          FVB=2.9517*DMB(K,M)**2/SNU
          GO TO 105
 104      CONTINUE
          FVB=(SQRT(36.064*DMB(K,M)**3+36.*SNU**2)-6.*SNU)/DMB(K,M)
 105      CONTINUE
          ZR=FVB/(0.4*SV)
          AR=2.*DMB(K,M)/HYRAD
          BMV=2.5+VMEAN/SV
          IF (AR.GT.0.9) GO TO 106
          CALL POWER (ZR,AR,FJ,SJ,1.0E-2)
          P=AR**(ZR-1.)/(11.6*(1.-AR)**ZR)
          SUSP=P*(BMV*FJ+2.5*SJ)
          IF (SUSP.LT.0.) SUSP=0.
          GO TO 107
 106      SUSP=0.
 107      CONTINUE
          TAOC=102.96*DELTS*DMB(K,M)
          IF (TAO.GT.TAOC) GO TO 108
          SEDD=0.
          SUSP=0.
          GO TO 109
 108      SEDD=AGR*(TAO-TAOC)**1.5
 109      SEDQ=(1.+SUSP)*SEDD
          SEDQ=SEDQ*Z*DEMAX*2.
          GBC(M)=SEDQ*PRO(K,M)
          GBCDS=GBCDS+GBC(M)
 110  CONTINUE
 111  CONTINUE
      DO 112 M=1,MM
          SGBUP=SGBUP+GBUP(M)
 112  CONTINUE
      IF (ITYP(K).GT.2) GO TO 114
      IF (SGBUP.LT.GBCDS) GO TO 113
      PRINT 119
      PRINT 117
      IFLGS=1
 113  CONTINUE
```

```
      IF (QUP.LT.QED) RETURN                                            CAP  820
      PRINT 119                                                         CAP  830
      PRINT 116                                                         CAP  840
      IFLGQ=1                                                           CAP  850
      RETURN                                                            CAP  860
  114 CONTINUE                                                          CAP  870
      IF (SGBUP.LT.GBCCS) GO TO 115                                     CAP  880
      PRINT 118                                                         CAP  890
      PRINT 117                                                         CAP  900
      IFLGS=1                                                           CAP  910
  115 CONTINUE                                                          CAP  920
      IF (QUP.LT.QEC) RETURN                                            CAP  930
      IFLGQ=1                                                           CAP  940
      PRINT 118                                                         CAP  950
      PRINT 116                                                         CAP  960
      RETURN                                                            CAP  970
C                                                                       CAP  980
  116 FORMAT (5X,56HUPSTREAM WATER INFLOW GREATER THAN TRANSPORTING CAPACAP  990
     1CITY/)                                                            CAP 1000
  117 FORMAT (5X,59HUPSTREAM SEDIMENT INFLOW GREATER THAN TRANSPORTING C
     1APACITY/)                                                         CAP 1020
  118 FORMAT (5X,20HCULVERT UNDER DESIGN/)                              CAP 1030
  119 FORMAT (5X,18HDITCH UNDER DESIGN/)                                CAP 1040
C                                                                       CAP 1050
      END                                                               CAP 1060
```

```
*
      SUBROUTINE  DPRNT (IT,DTS,KI )

      DIMENSION  QOUT(200,10), SGBO(200,10), GBOUT(10,20), GBCUR(20),
     & GBPRE(10,20), QPRE(20), SQOUT(10)

      COMMON /VAR1/  NSEG,NDX,NSTOM,IMAX,MM,
     & IPD,IPD1,ISV1,ISV2
      COMMON /VAR2/  IDSEG(2,10),SLEN(10),SLOP1(10),PERM(10),
     & ALPHA(10),CF(200,10),DMB(10,15),PBO(10,15),GC(10),Z,DIA,DEMAX,
     & DB4(10),SSUM,PMC(10),AMC(10),CN(10),GCI,CNI,
     & SINT(10),DNB(10,15)
X     COMMON /VAR3/  ISEG(010),IUP(010,3),ILAT(010,2),ITYP(010)
X     COMMON /VAR4/  ATM,PTM,AGB,BEX,ADF(10),DELTS
X     COMMON /VAR5/  FKL,OFL(10),OFH(10),COEFN,SNU,GRF,ERF
      COMMON /VAR6/  ISTORM(2,05),ITMAX(05),ITCOM(05),DR(05,200),
     & RCUM(10),RRNET(10),RPEXC(10)
      COMMON /VAR7/  EGB(15),GBC(15),ZBL(15),GBUP(15),GBLAT(15),
     & BLAT(15),BTEM(15),SB(10,10,15),RB(10,10,15),
     & SLOP(10,10),DDEP(15)
      COMMON /VAR8/  A(10,10),Q(100),QP(10,10),PB1(10,15),GBO(10,15)
      COMMON /VAR9/  PORB(15),ZSUM,ASUM,EPS,DT
X     COMMON /VAR10/  CPR,EPR,ALP,BET,SLP,ALAT,QUP,AUP,QE,QLAT,
X    & AREA,A1(10),B1(10)

   SIMULATION RESULTS MAY BE SAVED FOR PLOTTING
    SEE ' WRITE( ISV,ETC) ' BELOW


      ENTRY  DPRNT( IT,DTS,KI )


      INITILIZE ALL  VARIABLES

100   ITCOM1=ITCOM(KI)
      IF (IT.GT.1) GO TO 103
      IPD1 = 0
      PRINT 114, ( ISTORM(N,KI),N=1,2 ),ITMAX(KI),ITCOM1
      DO 101  IX=1,NSEG
         SQOUT(IX)=0.
         QPRE(IX)=0.
      DO 101  IY=1,MM
         GBCUR(IY)=0.
         GBPRE(IX,IY)=0.
         GBOUT(IX,IY)=0.
 101  CONTINUE
      DO 102  IX=1,ITCOM1
      DO 102  IY=1,NSEG
```

```
         QOUT(IX,IY)=0.
         SGBO(IX,IY)=0.
  102 CONTINUE
  103 CONTINUE
      DO 105 I=1,NSEG
         QCUR=Q(I)
         QOUT(IT,I)=0.5*(QCUR+QPRE(I))
         QPRE(I)=QCUR
         SQOUT(I)=SQOUT(I)+QOUT(IT,I)*DTS
         SGBO(IT,I)=0.

      CHANGE  THE  SEDIMENT  LOAD  TO  POUNDS

         DO 104 M=1,MM
            GBCUR(M)=GBO(I,M)*165.4*DTS
            GBOUT(I,M)=.5*(GBCUR(M)+GBPRE(I,M))
            GBPRE(I,M)=GBCUR(M)
            SGBO(IT,I)=SGBO(IT,I)+GBOUT(I,M)
  104    CONTINUE
  105 CONTINUE

      DISPLAY SEDIMENT CHARACTERISTICS

      IPD1 = IPD1 + 1
      IF( IPD1 .NE. IPD )  GOTO 306
        IPD1 = 0
        PRINT 210,  IT
        DO 106  I=1,NSEG
          PRINT 110,
     &           I,(IDSEG(N,I),N=1,2),(PB1(I,M),M=1,MM)
 106    CONTINUE
        IF(ISV1 .EQ. 0 )  GOTO 306
        DO 206  I=1,NSEG
          WRITE( ISV1,211)  (PB1(I,M),M=1,MM)
 206    CONTINUE
 306  IF( IT .LT. ITCOM1 )  RETURN

      DISPLAY YIELDS FOR EACH SEGMENT

      LINE=1
      DO 109 I=1,NSEG
         SSED=0.
         IF (LINE.GT.1) GO TO 107
         PRINT 112, I,(IDSEG(N,I),N=1,2)
         PRINT 115
      IF( ISV2 .NE. 0 )
     &  WRITE( ISV2,212)
     &           I,(IDSEG(N,I),N=1,2),NSEG,ITCOM1,DT
```

```
      LINE=LINE+1                                                       DPR  590
 107     CONTINUE                                                       DPR  600
      DO 108 IK=1,ITCOM1                                                DPR  610
         PRINT 111, IK,QOUT(IK,I),SGBO(IK,I)                            DPR  620
         SSED=SSED+SGBO(IK,I)                                           DPR  630
 108     CONTINUE                                                       DPR  640
      PRINT 113, SQOUT(I),SSED                                          DPR  650
      LINE = 1
      IF( ISV2 .EQ. 0 )  GOTO 109
        DO 208  IK=1,ITCOM1
          WRITE( ISV2,211)  ( IK,QOUT(IK,I),SGBO(IK,I))
208     CONTINUE
 109  CONTINUE                                                          DPR  660
      RETURN                                                            DPR  670
C                                                                       DPR  680
 210  FORMAT( /10X'CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS'
     & 5X'( PB1(I,J) )'
     & /15X'TIME-STEP ='I5 )
 110  FORMAT( 12X'SEGMENT-#'I3'  --   '2A4
     & /10X,14F8.5 /)
 111  FORMAT (10X,I10,5X,2E10.3)                                        DPR  700
 112  FORMAT( 1H1//10X'OUTFLOW FROM SEGMENT-#'I3' -- '2A4 )
 113  FORMAT( /10X'TOTAL YIELD:'5X'WATER'5X'SEDIMENT'
     & /26X'IN CFS.'5X'IN LBS.'
     & /25X,2F10.3 //)
 114  FORMAT( 10X'RAINFALL SIMULATION'
     & /12X'STORM ID. : '2A4,18X'( ISTORM )'
     & /12X'RAINFALL DURATION ='I4'  INCR.'8X'( ITMAX )'
     & /12X'RUNOFF DURATION ='I4'  INCR.'10X'( ITCOM )' /)
 115  FORMAT( /16X'TIME'8X'WATER'5X'SEDIMENT'
     & /15X'STEP-#'6X'IN CFS.'5X'IN LBS.' )
 211  FORMAT( I10,2E10.3 )
 212  FORMAT(
     &  'HYDROGRAPH FOR RUNOFF FROM SEGMENT#'I2' ('2A4')'
     & /'WATER AND SEDIMENT YEILDS .VS. SIMULATION TIME  '
     & /2I10,F10.3 )
C                                                                       DPR  770
      END                                                               DPR  780
```

```
C*
      SUBROUTINE DETCH (K,J,RAIN)
C
      COMMON /VAR1/  NSEG,NDX,NSTOM,IMAX,MM,
     & IPD,IPD1,ISV1,ISV2
      COMMON /VAR2/  IDSEG(2,10),SLEN(10),SLOP1(10),PERM(10),
     & ALPHA(10),CF(200,10),DMB(10,15),PBO(10,15),GC(10),Z,DTA,DEMAX,
     & DP4(10),SSUM,PMC(10),AMC(10),CN(10),GCI,CNI,
     & SINT(10),DNB(10,15)
      COMMON /VAR3/  ISEG(010),IUP(010,3),ILAT(010,2),ITYP(010)
      COMMON /VAR4/  AIM,BIM,AGB,BEX,ADF(10),DELTS
CX    COMMON /VAR5/  FKL,OFL(10),OFH(10),COEFN,SNU,GRF,ERF
CX    COMMON /VAR6/  ISTORM(2,05),ITMAX(05),ITCOM(05),DR(05,200),
CX   & RCUM(10),RRNET(10),RREXC(10)
      COMMON /VAR7/  EGB(15),GBC(15),ZBL(15),GBUP(15),GBLAT(15),
     & BLAT(15),BTEM(15),SB(10,10,15),RB(10,10,15),
     & SLOP(10,10),DDEP(15)
      COMMON /VAR8/  A(10,10),Q(100),QP(10,10),PB1(10,15),GBO(10,15)
      COMMON /VAR9/  PORB(15),ZSUM,ASUM,EPS,DT
      COMMON /VAR10/  CPR,EPR,ALP,BET,SLP,ALAT,QUP,AUP,QE,QLAT,
     & AREA,A1(10),B1(10)
C
C
C     ENTRY  DETCH( K,J,RAIN )
C
C     DETERMINATION OF THE AMOUNT OF SOIL DETACHED BY RAINDROP IMPACT
C
 100  IF( ITYP(K) .GE. 2 )  RETURN
      GCP=1.-GC(K)
      CNP=1.-CN(K)
      CNP=1.
      RIM=DT/60.*AIM*RAIN**BIM
      GMAX=6.69*RAIN**(.182)/304.8
      DEPTH=A(K,J)/A1(K)
      SPL=DEPTH+ZSUM/PORB(K)
      IF (SPL.GE.GMAX) RETURN
      PN=GMAX-SPL
      SDR=RIM*(1.-SPL/GMAX)
      IF (SDR.LE.PN) GO TO 101
      SDR=PN
  101 CONTINUE
      DO 102 M=1,MM
         ZBL(M)=ZBL(M)+SDR*PBO(K,M)*PORB(K)*GCP*CNP
  102 CONTINUE
      RETURN
C
      END
```

```
*********************************  SIGMA 5/6/7/9  LOAD MODULE MAP  **********************************
********************************* ACN= 1126GENL  <ROOT> START= D80C  *********************************
********************************  LMN= ROSED*             BIAS= A000   ********************************
*******************************   SGN= ROSED*             SIZE=017.7K   *******************************
               "+"=DBLE DEF "-"=LIB DEF "*"=UNUSED DEF "@"=UNUSED LIB DEF

************ PROTECTION TYPES **********
     00 DATA  01 PROCEDURE  10 STATIC
     -------  ------------  ---------
HIGH:  D40D        E8C3        D7FF
LOW :  A000        D800        D600
SIZE:  340E        10C4         200


*******  SECT - PROGRAM SECTIONS MAP                    ******

A35C DSECT 0  A35C 0  VAR1                                                                  -     A WDS
A366 DSECT 0  A366 0  VAR2                                                                  -   A10 WDS
AD76 DSECT 0  AD76 0  VAR3                                                                  -    46 WDS
ADBC DSECT 0  ADBC 0  VAR4                                                                  -    10 WDS
ADCC DSECT 0  ADCC 0  VAR5                                                                  -    1A WDS
ADE6 DSECT 0  ADE6 0  VAR6                                                                  -   41A WDS
B200 DSECT 0  B200 0  VAR7                                                                  -   C94 WDS
BE94 DSECT 0  BE94 0  VAR9                                                                  -    14 WDS
BEA8 DSECT 0  BEA8 0  VAR10                                                                 -    20 WDS
BEC8 CSECT 0  BEC8 0 *V#4MAIN                                                               -     2 WDS
BECA DSECT 0  BECA 0  VAR8                                                                  -   258 WDS
C122 CSECT 0  C122 0 *V#ROUTE                                                               -    14 WDS
C136 CSECT 0  C136 0 *V#INITL                                                               -    10 WDS
C146 CSECT 0  C146 0 *V#INFIL                                                               -    12 WDS
C158 CSECT 0  C158 0 *V#DATA1                                                               -    1E WDS
C176 CSECT 0  C176 0 *V#PERTG                                                               -    6C WDS
C1E2 CSECT 0  C1E2 0 *V#TRANS                                                               -    1C WDS
C1FE CSECT 0  C1FE 0 *V#FRICT                                                               -     8 WDS
C206 CSECT 0  C206 0 *V#UPLAT                                                               -     A WDS
C210 CSECT 0  C210 0 *V#WROUT                                                               -    1E WDS
C22E CSECT 0  C22E 0 *V#SROUT                                                               -    12 WDS
C240 CSECT 0  C240 0 *V#POWER                                                               -    14 WDS
C254 CSECT 0  C254 0 *V#CEASE                                                               -     8 WDS
C25C CSECT 0  C25C 0 *V#CULVT                                                               -     8 WDS
C264 CSECT 0  C264 0 *V#AGGDG                                                               -     6 WDS
```

```
C26A CSECT 0   C26A 0 *V#CAPA                                                                     -   22 WDS
C28C CSECT 0   C28C 0 *V#DPRNT                                                                    - 1172 WDS
D3FE CSECT 0   D3FE 0 *V#DETCH                                                                    -   10 WDS
D61C LDCB  2   D61C 0  M:*                                                                        -   2A WDS
D646 LDCB  2   D646 0  M:DO                                                                       -   34 WDS
D67A LDCB  2   D67A 0  M:OC                                                                       -   34 WDS
D6AE LDCB  2   D6AE 0  F:105                                                                      -   34 WDS
D6E2 LDCB  2   D6E2 0  F:108                                                                      -   34 WDS
D716 LDCB  2   D716 0  F:202                                                                      -   34 WDS
D74A LDCB  2   D74A 0  F:102                                                                      -   34 WDS
D77E LDCB  2   D77E 0  F:104                                                                      -   34 WDS
D7B2 LDCB  2   D7B2 0  F:106                                                                      -   34 WDS
D80C CSECT 1   D80C 0 *4MAIN                                                                      -   12 WDS
D81E CSECT 1   D81E 0  ROUTE                                                                      -  174 WDS
D992 CSECT 1   D992 0  INITL                                                                      -   C8 WDS
DA5A CSECT 1   DA5A 0  INFIL                                                                      -   58 WDS
DAB2 CSECT 1   DAB2 0  DATA1                                                                      -  4A0 WDS
DF52 CSECT 1   DF52 0  PERTG                                                                      -   38 WDS
DF8A CSECT 1   DF8A 0  TRANS                                                                      -  1D4 WDS
E15E CSECT 1   E15E 0  FRICT                                                                      -   34 WDS
E192 CSECT 1   E192 0  UPLAT                                                                      -   6A WDS
E1FC CSECT 1   E1FC 0  WROUT                                                                      -   B0 WDS
E2AC CSECT 1   E2AC 0  SROUT                                                                      -   A4 WDS
E350 CSECT 1   E350 0  POWER                                                                      -   72 WDS
E3C2 CSECT 1   E3C2 0  CEASE                                                                      -   48 WDS
E40A CSECT 1   E40A 0  CULVT                                                                      -   6A WDS
E474 CSECT 1   E474 0  AGGDG                                                                      -   5E WDS
E4D2 CSECT 1   E4D2 0  CAPA                                                                       -  1A0 WDS
E672 CSECT 1   E672 0  DPRNT                                                                      -  1F6 WDS
E868 CSECT 1   E868 0  DETCH                                                                      -   5A WDS

*******   RELOCATABLE DEFINITIONS SORTED BY NAME   ******
               E474 0  AGGDG      E4D2 0  CAPA       E3C2 0  CEASE      E40A 0  CULVT
               DAB2 0  DATA1      E868 0  DETCH      E672 0  DPRNT      D74A 0  F:102
               D77E 0  F:104      D6AE 0  F:105      D7B2 0  F:106      D6E2 0  F:108
               D716 0  F:202      E15E 0  FRICT      DA5A 0  INFIL      D992 0  INITL
               D61C 0  M:*        D646 0  M:DO       D67A 0  M:OC       DF52 0  PERTG
               E350 0  POWER      D81E 0  ROUTE      E2AC 0  SROUT      DF8A 0  TRANS
               E192 0  UPLAT      C264 0 *V#AGGDG    C26A 0 *V#CAPA     C254 0 *V#CEASE
               C25C 0 *V#CULVT    C158 0 *V#DATA1    D3FE 0 *V#DETCH    C28C 0 *V#DPRNT
               C1FE 0 *V#FRICT    C146 0 *V#INFIL    C136 0 *V#INITL    C176 0 *V#PERTG
```

```
             C240 0 *V#POWER      C122 0 *V#ROUTE      C22E 0 *V#SROUT      C1E2 0 *V#TRANS
             C206 0 *V#UPLAT      C210 0 *V#WROUT      BEC8 0 *V#4MAIN      A35C 0  VAR1
             BEA8 0  VAR10        A366 0  VAR2         AD76 0  VAR3         AD8C 0  VAR4
             ADCC 0  VAR5         ADE6 0  VAR6         B200 0  VAR7         BECA 0  VAR8
             BF94 0  VAR9         E1FC 0  WROUT        D80C 0 *4MAIN


*******  DEF - PROGRAM DEFINITIONS MAP           ******

A35C DSECT 0    A35C 0  VAR1                                                                -    A WDS
A366 DSECT 0    A366 0  VAR2                                                                -  A10 WDS
AD76 DSECT 0    AD76 0  VAR3                                                                -   46 WDS
AD8C DSECT 0    AD8C 0  VAR4                                                                -   10 WDS
ADCC DSECT 0    ADCC 0  VAR5                                                                -   1A WDS
ADE6 DSECT 0    ADE6 0  VAR6                                                                -  41A WDS
B200 DSECT 0    B200 0  VAR7                                                                -  C94 WDS
BE94 DSECT 0    BE94 0  VAR9                                                                -   14 WDS
BEA8 DSECT 0    BEA8 0  VAR10                                                               -   20 WDS
BEC8 CSECT 0    BEC8 0 *V#4MAIN                                                             -    2 WDS
BECA DSECT 0    BECA 0  VAR8                                                                -  258 WDS
C122 CSECT 0    C122 0 *V#ROUTE                                                             -   14 WDS
C136 CSECT 0    C136 0 *V#INITL                                                             -   10 WDS
C146 CSECT 0    C146 0 *V#INFIL                                                             -   12 WDS
C158 CSECT 0    C158 0 *V#DATA1                                                             -   1E WDS
C176 CSECT 0    C176 0 *V#PERTG                                                             -   6C WDS
C1E2 CSECT 0    C1E2 0 *V#TRANS                                                             -   1C WDS
C1FE CSECT 0    C1FE 0 *V#FRICT                                                             -    8 WDS
C206 CSECT 0    C206 0 *V#UPLAT                                                             -    4 WDS
C210 CSECT 0    C210 0 *V#WROUT                                                             -   1E WDS
C22E CSECT 0    C22E 0 *V#SROUT                                                             -   12 WDS
C240 CSECT 0    C240 0 *V#POWER                                                             -   14 WDS
C254 CSECT 0    C254 0 *V#CEASE                                                             -    8 WDS
C25C CSECT 0    C25C 0 *V#CULVT                                                             -    8 WDS
C264 CSECT 0    C264 0 *V#AGGDG                                                             -    6 WDS
C26A CSECT 0    C26A 0 *V#CAPA                                                              -   22 WDS
C28C CSECT 0    C28C 0 *V#DPRNT                                                             - 1172 WDS
D3FE CSECT 0    D3FE 0 *V#DETCH                                                             -   10 WDS
D61C LDCB  2    D61C 0  M:*                                                                 -   2A WDS
D646 LDCB  2    D646 0  M:DO                                                                -   34 WDS
D67A LDCB  2    D67A 0  M:OC                                                                -   34 WDS
```

```
D6AE LDCB  2   D6AE 0  F:105                                       -   34 WDS
D6E2 LDCB  2   D6E2 0  F:108                                       -   34 WDS
D716 LDCB  2   D716 0  F:202                                       -   34 WDS
D74A LDCB  2   D74A 0  F:102                                       -   34 WDS
D77E LDCB  2   D77E 0  F:104                                       -   34 WDS
D7B2 LDCB  2   D7B2 0  F:106                                       -   34 WDS
D80C CSECT 1   D80C 0 *4MAIN                                       -   12 WDS
D81E CSECT 1   D81E 0  ROUTE                                       -  174 WDS
D992 CSECT 1   D992 0  INITL                                       -   C8 WDS
DA5A CSECT 1   DA5A 0  INFIL                                       -   58 WDS
DAB2 CSECT 1   DAB2 0  DATA1                                       -  4A0 WDS
DF52 CSECT 1   DF52 0  PERTG                                       -   38 WDS
DF8A CSECT 1   DF8A 0  TRANS                                       -  1D4 WDS
E15E CSECT 1   E15E 0  FRICT                                       -   34 WDS
E192 CSECT 1   E192 0  UPLAT                                       -   6A WDS
E1FC CSECT 1   E1FC 0  WROUT                                       -   B0 WDS
E2AC CSECT 1   E2AC 0  SROUT                                       -   A4 WDS
E350 CSECT 1   E350 0  POWER                                       -   72 WDS
E3C2 CSECT 1   E3C2 0  CEASE                                       -   48 WDS
E40A CSECT 1   E40A 0  CULVT                                       -   6A WDS
E474 CSECT 1   E474 0  AGGDG                                       -   5E WDS
E4D2 CSECT 1   E4D2 0  CAPA                                        -  1A0 WDS
E672 CSECT 1   E672 0  OPRNT                                       -  1F6 WDS
E868 CSECT 1   E868 0  DETCH                                       -   5A WDS
```

```
C*
C      HYDRG   PROGRAM
C                                                         AUTHOR:  DR POOLE
C
C      THIS PROGRAM IS USED IN CONJUNCTION WITH THE MSU ROSED
C         SIMULATION MODEL TO PRODUCE GRAPHIC DISPLAYS OF
C         SEDIMENT AND WATER HYDROGRAPHS FOR RUNOFF.
C
C
C
C      PROGRAM  HYDRG
C      EXTERNAL  DRAW
C
       INTEGER   ITITLE(24),ITITL2(12),LSGBO,LQOUT
       INTEGER  LAST,BLNK,ISV2
       EQUIVALENCE  ( ITITLE(13),ITITL2(1))
       REAL  TIME(300),SGBO(300),QOUT(300)
C
       DATA  LSGBO / 4HSGBO /
       DATA  LQOUT / 4HQOUT /
       DATA  BLNK  / 4H     /
       DATA  LAST  / 4HLAST /
       DATA  ISV2  / 202 /
C
C
C  READ INFO FROM SAVE-FILES OF LAST "ROSED" EXECUTION
C
 400   PRINT 21
  21   FORMAT( 1H1/5X"GRAPHIC DISPLAYS FOR SIMULATED RUNOFF" /)
C
       READ( ISV2,11, END=460)  ( ITITLE(N),N=1,24 )
       PRINT 11,  ( ITITLE(N),N=1,24 )
  11   FORMAT( 12A4/12A4 )
C
       READ( ISV2,12)  ( NSEG,ITCOM1,DT )
       PRINT  12,  ( NSEG,ITCOM1,DT )
  12   FORMAT( 2I10,F10.3 )
       ITCOM = ITCOM1
       IF( ITCOM1 .GT. 300 )  ITCOM = 300
C
       DO 450  I=1,NSEG
          PRINT 22
  22      FORMAT( /5X"READING RUNOFF DATA"
     & /8X"II   TIME"6X"SGBO"5X"QOUT" /)
          DO 410  IK=1,ITCOM
C
             READ( ISV2,14, END=412)  ( II,QOUT(IK),SGBO(IK) )
  14         FORMAT( I10,2F10.3 )
```

```
              TIME(IK) = ( II * DT )
              PRINT 23,  IK,TIME(IK),SGBO(IK),QOUT(IK)
   23         FORMAT( 5X,I5,3E10.3  )
  410       CONTINUE
            GOTO 414
C
  412       PRINT 26,  IK
   26       FORMAT( //5X'** EOF HIT AFTER'I5 /)
C
  414       PRINT 24,  I
   24       FORMAT( /5X'DRAWING HYDROGRAPHS FOR SEGMENT-#'I2 /)
C
C
            ENCODE( 48,31,ITITL2 )
   31       FORMAT( 'SEDIMENT YEILD (IN LBS.) .VS. TIME (IN MINUTES)' )
            CALL DRAW( TIME,SGBO,ITCOM,0,0,
     &                 LSGBO,ITITLE,0.0,0.0,0,0,6,6,0,BLNK )
C
            ENCODE( 84,32,ITITL2 )
   32       FORMAT( 'WATER RUNOFF (IN CFS.) .VS. TIME (IN MINUTES)   ' )
            CALL DRAW( TIME,QOUT,ITCOM,0,0,
     &                 LQOUT,ITITLE,0.0,0.0,0,0,6,6,0,LAST )
C
          IF( ITCOM .GT. 300 )  GOTO 455
  450     CONTINUE
          GOTO 460
C
  455     PRINT 25,   I
   25     FORMAT( //5X'** RUNOFF DURATION TOO LONG --'
     &    ' DATA STORAGE OVERFLOW'
     &    //5X'-- EXECUTION SUSPENDED AFTER SEGMENT'I2 //)
C
  460     CALL CLRPLT
          CALL EXIT
          END
```

```
*********************************  SIGMA 5/6/7/9  LOAD MODULE MAP  **********************************
******************************** ACN= 1126GENL  <ROOT> START= 8A0C  *********************************
*******************************  LMN= HYDRG*             BIAS= A000   ********************************
******************************   SGN= HYDRG*             SIZE=006.9K   *******************************
                  "+"=DBLE DEF "-"=LIB DEF "*"=UNUSED DEF "@"=UNUSED LIB DEF

************ PROTECTION TYPES **********
     00 DATA  01 PROCEDURE  10 STATIC
     -------  ------------  ---------
HIGH:  B72D        8C71         B9FF
LOW :  A000        8A00         B800
SIZE:  172E         272          200


*******  SECT - PROGRAM SECTIONS MAP                              ******

A35C CSECT 0   A35C 0 *V#4MAIN                                                                        -  3AA WDS
A706 CSECT 0   A717 0 *FCTR                                                                           -   FC WDS
A718 CSECT 0   A718 0  CLRPLT                                                                         -    4 WDS
A71B CSECT 0   A71B 0 *OFFSET                                                                         -      WDS
A727 CSECT 0   A727 0 *FACTOR                                                                         -      WDS
A72C CSECT 0   A72C 0  WHERE                                                                          -    4 WDS
A73E CSECT 0   A73E 0  PLOT                                                                           -    4 WDS
A76B CSECT 0   A76B 0  SYMBOL                                                                         -    4 WDS
A796 CSECT 0   A796 0 *NUPAGE                                                                         -      WDS
A7A4 CSECT 0   A7A4 0 *LIMITS                                                                         -      WDS
A7B3 CSECT 0   A7B3 0 *PLOTFORM                                                                       -      WDS
A7C5 CSECT 0   A7C5 0 *XLIMIT                                                                         -      WDS
A7CC CSECT 0   A7CC 0 *PLDATE                                                                         -      WDS
A7DB CSECT 0   A7DB 0 *PLSYSID                                                                        -      WDS
A802 CSECT 0   A959 0  CHAR                                                                           -  1F4 WDS
A9F6 CSECT 0   A9FF 0  INCPIN                                                                         -   FE WDS
AA00 CSECT 0   AA00 0  STEPSPIN                                                                       -    4 WDS
AA02 CSECT 0   AA02 0 *YLIM                                                                           -      WDS
AA05 CSECT 0   AA05 0  XLIM                                                                           -    4 WDS
AA0A CSECT 0   AA0A 0  XPEN                                                                           -    4 WDS
AA0B CSECT 0   AA0B 0  YPEN                                                                           -    4 WDS
AA0F CSECT 0   AA0F 0  XMAX                                                                           -    4 WDS
AA70 CSECT 0   AA70 0  BOUND                                                                          -    4 WDS
AA72 CSECT 0   AA72 0  INITLIZE                                                                       -    4 WDS
AA7C CSECT 0   AA7C 0  PENUP                                                                          -    4 WDS
```

```
AA88 CSECT 0    AA88 0  PENDN                                                                           -     4 WDS
AA8D CSECT 0    AA8D 0  MOVE                                                                            -     4 WDS
B81C LDCB  2    B81C 0  M:*                                                                             -    2A WDS
B846 LDCB  2    B846 0  M:DO                                                                            -    34 WDS
B87A LDCB  2    B87A 0  M:OC                                                                            -    34 WDS
B8AE DSECT 2    B8AE 0  M:PL                                                                            -    16 WDS
B8C4 LDCB  2    B8C4 0  F:108                                                                           -    34 WDS
B8F8 LDCB  2    B8F8 0  F:202                                                                           -    34 WDS
B92C LDCB  2    B92C 0  F:101                                                                           -    34 WDS
B960 LDCB  2    B960 0  F:103                                                                           -    34 WDS
B994 LDCB  2    B994 0  F:105                                                                           -    34 WDS
BA0C CSECT 1    BA0C 0 *4MAIN                                                                           -   126 WDS
BC40 CSECT 1                                                                                            -    30 WDS

*******  RELOCATABLE DEFINITIONS SORTED BY NAME  ******
                AA70 0  BOUND           A959 0  CHAR            A718 0  CLRPLT          B92C 0  F:101
                B960 0  F:103           B994 0  F:105           B8C4 0  F:108           B8F8 0  F:202
                A727 0 *FACTOR          A717 0 *FCTR            A9FF 0  INCPIN          AA72 0  INITLIZE
                A7A4 0 *LIMITS          B81C 0  M:*             B846 0  M:DO            B87A 0  M:OC
                B8AE 0  M:PL            AA8D 0  MOVE            A796 0 *NUPAGE          A718 0 *OFFSET
                AA88 0  PENDN           AA7C 0  PENUP           A7CC 0 *PLDATE          A73E 0  PLOT
                A7B3 0 *PLOTFORM        A7DB 0 *PLSYSID         AA00 0  STEPSPIN        A768 0  SYMBOL
                A35C 0 *V#4MAIN         A72C 0  WHERE           AA05 0  XLIM            A7C5 0 *XLIMIT
                AA0F 0  XMAX            AA0A 0  XPEN            AA02 0 *YLIM            AA0B 0  YPEN
                BA0C 0 *4MAIN


*******  DEF - PROGRAM DEFINITIONS MAP                  ******

A35C CSECT 0    A35C 0 *V#4MAIN                                                                         -   3AA WDS
A706 CSECT 0    A717 0 *FCTR            A718 0  CLRPLT          A718 0 *OFFSET          A727 0 *FACTOR  -    FC WDS
                A72C 0  WHERE           A73E 0  PLOT            A768 0  SYMBOL          A796 0 *NUPAGE
                A7A4 0 *LIMITS          A7B3 0 *PLOTFORM        A7C5 0 *XLIMIT          A7CC 0 *PLDATE
                A7DB 0 *PLSYSID
A802 CSECT 0    A959 0  CHAR                                                                            -   1F4 WDS
A9F6 CSECT 0    A9FF 0  INCPIN          AA00 0  STEPSPIN        AA02 0 *YLIM            AA05 0  XLIM    -    FE WDS
                AA0A 0  XPEN            AA0B 0  YPEN            AA0F 0  XMAX            AA70 0  BOUND
                AA72 0  INITLIZE        AA7C 0  PENUP           AA88 0  PENDN           AA8D 0  MOVE
B81C LDCB  2    B81C 0  M:*                                                                             -    2A WDS
B846 LDCB  2    B846 0  M:DO                                                                            -    34 WDS
```

```
B87A LDCB  2   B87A 0  M:OC                                                                     -   34 WDS
B8AE DSECT 2   B8AE 0  M:PL                                                                     -   16 WDS
B8C4 LDCB  2   B8C4 0  F:108                                                                    -   34 WDS
B8F8 LDCB  2   B8F8 0  F:202                                                                    -   34 WDS
B92C LDCB  2   B92C 0  F:101                                                                    -   34 WDS
B960 LDCB  2   B960 0  F:103                                                                    -   34 WDS
B994 LDCB  2   B994 0  F:105                                                                    -   34 WDS
BA0C CSECT 1   BA0C 0 *4MAIN                                                                    -  126 WDS
BC40 CSECT 1                                                                                    -   30 WDS
```

APPENDIX II

Sample Computer Printout of CSU Road Sediment Model using Gilley's et al. (8) erosion plot data from a mine spoils in North Dakota.

```
NAME = STUDY:1

   1 - JOHN GILLEY'S DATA   CLAY LOAM SITE        10% SLOPE   CULTIVATED BARE SPOIL
   2 -          1         0         0        10         1        50        11
   3 - 0.01      0.50       1.050E-05        20         0       202
   4 -          1         0         0         0         0         0         1
   5 -   OERLD#01 72.6    0.10    0.800   0.050   0.00    0.00    0.11    0.11
   6 -  1.00      3.00      0.50      0.00      0.00
   7 -  50.00     0.024
   8 -  1.00      0.00      400.00    400.00
   9 - 0.00154 0.00245 0.00397 0.00598 0.0079  0.0415  0.112   0.29    1.21    3.38
  10 - 8.73
  11 - 0.425   0.05    0.115   0.04    0.06    0.18    0.04    0.045   0.035   0.005
  12 - 0.005
  13 -  0.0004    2.00      0.056     1.50      0.047
  14 -  0.014     0.00
  15 -   PURDUE1       120       180
  16 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  17 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  18 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  19 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  20 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  21 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  22 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  23 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  24 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  25 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  26 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  27 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
```

```
GENERAL WATERSHED MODELING CONDITIONS
JOHN GILLEY'S DATA   CLAY LOAM SITE        10% SLOPE   CULTIVATED BARE SPOIL
       NOV     NDITCH    NCULVT      NDX     NSTOM      IMAX       MM
         1         0         0        10         1        50        11


  CONVERGENCE CRITERION =       .010                  ( EPS )
  TIME INCREMENT =       .500  MINUTES                ( DT  )
  KINEMATIC VISCOSITY =  .105E-04  SQ.FT / SEC        ( SNU )
  PARTICLE DISTRIBUTIONS DISPLAYED EVERY 20 TIME-STEPS


COMPUTATION SEQUENCE AND RESPONSE UNITS
      ISEG     IUP.1     IUP.2     IUP.3    ILAT.1    ILAT.2      ITYP
         1         0         0         0         0         0         1

BASIN CHARACTERISTICS AND GEOMETRY
 NSEG      IDSEG      SLEN     SLOP1      PERM     ALPHA        GC        CN       PMC       AMC
    1     DERLD#01   72.600      .100      .800      .050      .000      .000      .110      .110

  SIDE SLOPE OF DITCH =      1.000  FT.  H:V          ( Z      )
  DIAMETER OF CULVERT =      3.000  FT.               ( DIA    )
  MAXIMUM DEPTH OF DITCH =      .500  FT.             ( DEMAX )
  VOL OF INTER BY GROUND COVER =      .000  CU.IN     ( GCI   )
  VOL OF INTER BY CANOPY COVER =      .000  CU.IN     ( CNI   )


FLOW RESISTANCE PARAMETERS
      FKL         COEFN
    50.00000      .02400


CHANNEL CHARATERISTICS AND FLOW RESISTANCE
 NSEG      A1          B1          OFL         OFH
    1     1.00000     .00000   400.00000   400.00000
```

```
CHARACTERISTICS OF AVAILABLE SEDIMENT
  PARTICLE SIZE CLASSES (MM.) IN SEGMENT-#  1 -- DERLD#01      ( DNB(I,J) )
  .00154  .00245  .00397  .00598  .00790  .04150  .11200  .29000 1.21000 3.38000 8.73000
  CUMMULATIVE DISTRIBUTION IN SEGMENT-#  1 -- DERLD#01         ( PBO(I,J) )
  .42500  .05000  .11500  .04000  .06000  .18000  .04000  .04500  .03500  .00500  .00500

SEDIMENT ROUTING PARAMETERS
      AIM         BIM         AGB         BEX         DELTS
     .00040     2.00000      .05600     1.50000      .04700

RUNOFF DETACHMENT COEFFICIENTS
  ADF.1   ADF.
  .01400

RAINFALL SIMULATION
  STORM ID. :  PURDUE1               ( ISTORM )
  RAINFALL DURATION = 120  INCR.     ( ITMAX  )
  RUNOFF DURATION = 180  INCR.       ( ITCOM  )


RAINFALL INTENSITY  PER TIME INCREMENT
     TE:    54.321  IN./HR.        ( DR(I,J) )
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
```

```
RUNOFF SIMULATION  BY SEGMENT
  TIME INCREMENT =       .500  MINUTES      ( DT     )
  RUNOFF DURATION = 180  INCR.              ( ITCOM )
  RAINFALL DURATION = 120  INCR.            ( ITMAX )

RAINFALL SIMULATION
  STORM ID. :  PURDUE1                  ( ISTORM )
  RAINFALL DURATION = 120  INCR.        ( ITMAX )
  RUNOFF DURATION = 180  INCR.          ( ITCOM )


CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS     ( PB1(I,J) )
     TIME-STEP =   20
  SEGMENT-#  1  --  OERLD#01
  .02380  .00280  .00644  .00224  .00336  .36831  .18572  .15263  .19810  .02830  .02830

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS     ( PB1(I,J) )
     TIME-STEP =   40
  SEGMENT-#  1  --  OERLD#01
  .02247  .00264  .00608  .00211  .00317  .24260  .15619  .17809  .30072  .04296  .04296

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS     ( PB1(I,J) )
     TIME-STEP =   60
  SEGMENT-#  1  --  OERLD#01
  .02059  .00242  .00557  .00194  .00291  .19732  .11778  .18436  .36330  .05190  .05190

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS     ( PB1(I,J) )
     TIME-STEP =   80
  SEGMENT-#  1  --  OERLD#01
  .02062  .00243  .00558  .00194  .00291  .19285  .00194  .20405  .44153  .06308  .06308

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS     ( PB1(I,J) )
     TIME-STEP =  100
  SEGMENT-#  1  --  OERLD#01
  .01881  .00221  .00509  .00177  .00266  .15921  .01870  .18944  .46831  .06690  .06690

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS     ( PB1(I,J) )
     TIME-STEP =  120
  SEGMENT-#  1  --  OERLD#01
  .01728  .00203  .00468  .00163  .00244  .13607  .03296  .17736  .48654  .06951  .06951

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS     ( PB1(I,J) )
     TIME-STEP =  140
  SEGMENT-#  1  --  OERLD#01
  .18669  .02196  .05052  .01757  .02636  .05654  .04199  .14736  .35079  .05011  .05011

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS     ( PB1(I,J) )
     TIME-STEP =  160
  SEGMENT-#  1  --  OERLD#01
  .15939  .01875  .04313  .01500  .02250  .06649  .04775  .15562  .36661  .05237  .05237

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS     ( PB1(I,J) )
     TIME-STEP =  180
  SEGMENT-#  1  --  OERLD#01
  .13712  .01613  .03710  .01291  .01936  .07011  .05006  .16313  .38429  .05490  .05490
```

```
OUTFLOW FROM SEGMENT-#  1 -- OERLO#01

     TIME          WATER      SEDIMENT
    STEP-#        IN CFS.      IN LBS.
        1        .505E-05   .268E-03
        2        .454E-04   .279E-02
        3        .177E-03   .136E-01
        4        .458E-03   .452E-01
        5        .901E-03   .111E 00
        6        .142E-02   .207E 00
        7        .191E-02   .295E 00
        8        .228E-02   .350E 00
        9        .253E-02   .361E 00
       10        .267E-02   .367E 00
       11        .276E-02   .354E 00
       12        .280E-02   .341E 00
       13        .283E-02   .325E 00
       14        .284E-02   .312E 00
       15        .285E-02   .295E 00
       16        .285E-02   .283E 00
       17        .285E-02   .268E 00
       18        .286E-02   .258E 00
       19        .286E-02   .247E 00
       20        .286E-02   .238E 00
       21        .286E-02   .231E 00
       22        .286E-02   .224E 00
       23        .286E-02   .217E 00
       24        .286E-02   .212E 00
       25        .286E-02   .207E 00
       26        .286E-02   .202E 00
       27        .286E-02   .198E 00
       28        .286E-02   .194E 00
       29        .286E-02   .191E 00
       30        .286E-02   .188E 00
       31        .286E-02   .185E 00
       32        .286E-02   .183E 00
       33        .286E-02   .181E 00
       34        .286E-02   .178E 00
       35        .286E-02   .177E 00
```

```
36          .286E-02   .174E 00
37          .286E-02   .173E 00
38          .286E-02   .171E 00
39          .286E-02   .170E 00
40          .286E-02   .168E 00
41          .286E-02   .167E 00
42          .286E-02   .165E 00
43          .286E-02   .164E 00
44          .286E-02   .162E 00
45          .286E-02   .161E 00
46          .286E-02   .160E 00
47          .286E-02   .159E 00
48          .286E-02   .157E 00
49          .286E-02   .157E 00
50          .286E-02   .155E 00
51          .286E-02   .155E 00
52          .286E-02   .153E 00
53          .286E-02   .153E 00
54          .286E-02   .152E 00
55          .286E-02   .151E 00
56          .286E-02   .150E 00
57          .286E-02   .149E 00
58          .286E-02   .148E 00
59          .286E-02   .148E 00
60          .286E-02   .147E 00
61          .286E-02   .146E 00
62          .286E-02   .144E 00
63          .286E-02   .145E 00
64          .286E-02   .142E 00
65          .286E-02   .143E 00
66          .286E-02   .140E 00
67          .286E-02   .140E 00
68          .286E-02   .139E 00
69          .286E-02   .138E 00
70          .286E-02   .138E 00
71          .286E-02   .137E 00
72          .286E-02   .137E 00
73          .286E-02   .136E 00
74          .286E-02   .135E 00
75          .286E-02   .135E 00
76          .286E-02   .134E 00
```

```
  77         .286E-02  .134E 00
  78         .286E-02  .133E 00
  79         .286E-02  .132E 00
  80         .286E-02  .132E 00
  81         .286E-02  .131E 00
  82         .286E-02  .131E 00
  83         .286E-02  .130E 00
  84         .286E-02  .130E 00
  85         .286E-02  .129E 00
  86         .286E-02  .129E 00
  87         .286E-02  .128E 00
  88         .286E-02  .127E 00
  89         .286E-02  .127E 00
  90         .286E-02  .126E 00
  91         .286E-02  .126E 00
  92         .286E-02  .125E 00
  93         .286E-02  .125E 00
  94         .286E-02  .124E 00
  95         .286E-02  .124E 00
  96         .286E-02  .123E 00
  97         .286E-02  .123E 00
  98         .286E-02  .123E 00
  99         .286E-02  .122E 00
 100         .286E-02  .122E 00
 101         .286E-02  .121E 00
 102         .286E-02  .121E 00
 103         .286E-02  .120E 00
 104         .286E-02  .120E 00
 105         .286E-02  .119E 00
 106         .286E-02  .119E 00
 107         .286E-02  .118E 00
 108         .286E-02  .118E 00
 109         .286E-02  .118E 00
 110         .286E-02  .117E 00
 111         .286E-02  .117E 00
 112         .286E-02  .116E 00
 113         .286E-02  .116E 00
 114         .286E-02  .116E 00
 115         .286E-02  .115E 00
 116         .286E-02  .115E 00
 117         .286E-02  .115E 00
```

```
118          .286E-02   .114E 00
119          .286E-02   .114E 00
120          .286E-02   .113E 00
121          .243E-02   .672E-01
122          .173E-02   .513E-01
123          .129E-02   .499E-01
124          .100E-02   .372E-01
125          .802E-03   .391E-01
126          .657E-03   .297E-01
127          .548E-03   .308E-01
128          .466E-03   .249E-01
129          .402E-03   .247E-01
130          .350E-03   .211E-01
131          .309E-03   .205E-01
132          .275E-03   .180E-01
133          .246E-03   .174E-01
134          .222E-03   .155E-01
135          .202E-03   .150E-01
136          .184E-03   .135E-01
137          .169E-03   .131E-01
138          .156E-03   .119E-01
139          .144E-03   .116E-01
140          .134E-03   .105E-01
141          .125E-03   .103E-01
142          .117E-03   .942E-02
143          .110E-03   .923E-02
144          .103E-03   .848E-02
145          .970E-04   .833E-02
146          .916E-04   .767E-02
147          .867E-04   .755E-02
148          .822E-04   .698E-02
149          .781E-04   .688E-02
150          .743E-04   .638E-02
151          .708E-04   .630E-02
152          .676E-04   .586E-02
153          .646E-04   .579E-02
154          .618E-04   .540E-02
155          .592E-04   .534E-02
156          .568E-04   .499E-02
157          .545E-04   .493E-02
158          .524E-04   .462E-02
```

```
       159         .505E-04  .457E-02
       160         .486E-04  .428E-02
       161         .468E-04  .424E-02
       162         .452E-04  .399E-02
       163         .437E-04  .395E-02
       164         .422E-04  .373E-02
       165         .408E-04  .369E-02
       166         .395E-04  .349E-02
       167         .382E-04  .346E-02
       168         .371E-04  .328E-02
       169         .359E-04  .325E-02
       170         .349E-04  .309E-02
       171         .339E-04  .306E-02
       172         .329E-04  .291E-02
       173         .320E-04  .289E-02
       174         .311E-04  .276E-02
       175         .303E-04  .273E-02
       176         .294E-04  .261E-02
       177         .287E-04  .259E-02
       178         .279E-04  .248E-02
       179         .272E-04  .246E-02
       180         .266E-04  .235E-02

TOTAL YIELD:     WATER     SEDIMENT
                IN CFS.     IN LBS.
                 .102E 02  .200E 02
```

```
     GRAPHIC DISPLAYS FOR SIMULATED RUNOFF

HYDROGRAPH FOR RUNOFF FROM SEGMENT# 1 (OERLD#01)
WATER AND SEDIMENT YEILDS .VS. SIMULATION TIME
       1      180      .500

     READING RUNOFF DATA
       IT   TIME       SGBO       QOUT

        1  .500E 00  .268E-03  .505E-05
        2  .100E 01  .279E-02  .454E-04
        3  .150E 01  .136E-01  .177E-03
        4  .200E 01  .452E-01  .458E-03
        5  .250E 01  .111E 00  .901E-03
        6  .300E 01  .207E 00  .142E-02
        7  .350E 01  .295E 00  .191E-02
        8  .400E 01  .350E 00  .228E-02
        9  .450E 01  .361E 00  .253E-02
       10  .500E 01  .367E 00  .267E-02
       11  .550E 01  .354E 00  .276E-02
       12  .600E 01  .341E 00  .280E-02
       13  .650E 01  .325E 00  .283E-02
       14  .700E 01  .312E 00  .284E-02
       15  .750E 01  .295E 00  .285E-02
       16  .800E 01  .283E 00  .285E-02
       17  .850E 01  .268E 00  .285E-02
       18  .900E 01  .258E 00  .286E-02
       19  .950E 01  .247E 00  .286E-02
       20  .100E 02  .238E 00  .286E-02
       21  .105E 02  .231E 00  .286E-02
       22  .110E 02  .224E 00  .286E-02
       23  .115E 02  .217E 00  .286E-02
       24  .120E 02  .212E 00  .286E-02
       25  .125E 02  .207E 00  .286E-02
       26  .130E 02  .202E 00  .286E-02
       27  .135E 02  .198E 00  .286E-02
       28  .140E 02  .194E 00  .286E-02
       29  .145E 02  .191E 00  .286E-02
       30  .150E 02  .188E 00  .286E-02
       31  .155E 02  .185E 00  .286E-02
```

```
32   .160E 02   .183E 00   .286E-02
33   .165E 02   .181E 00   .286E-02
34   .170E 02   .178E 00   .286E-02
35   .175E 02   .177E 00   .286E-02
36   .180E 02   .174E 00   .286E-02
37   .185E 02   .173E 00   .286E-02
38   .190E 02   .171E 00   .286E-02
39   .195E 02   .170E 00   .286E-02
40   .200E 02   .168E 00   .286E-02
41   .205E 02   .167E 00   .286E-02
42   .210E 02   .165E 00   .286E-02
43   .215E 02   .164E 00   .286E-02
44   .220E 02   .162E 00   .286E-02
45   .225E 02   .161E 00   .286E-02
46   .230E 02   .160E 00   .286E-02
47   .235E 02   .159E 00   .286E-02
48   .240E 02   .157E 00   .286E-02
49   .245E 02   .157E 00   .286E-02
50   .250E 02   .155E 00   .286E-02
51   .255E 02   .155E 00   .286E-02
52   .260E 02   .153E 00   .286E-02
53   .265E 02   .153E 00   .286E-02
54   .270E 02   .152E 00   .286E-02
55   .275E 02   .151E 00   .286E-02
56   .280E 02   .150E 00   .286E-02
57   .285E 02   .149E 00   .286E-02
58   .290E 02   .148E 00   .286E-02
59   .295E 02   .148E 00   .286E-02
60   .300E 02   .147E 00   .286E-02
61   .305E 02   .146E 00   .286E-02
62   .310E 02   .144E 00   .286E-02
63   .315E 02   .145E 00   .286E-02
64   .320E 02   .142E 00   .286E-02
65   .325E 02   .143E 00   .286E-02
66   .330E 02   .140E 00   .286E-02
67   .335E 02   .140E 00   .286E-02
68   .340E 02   .139E 00   .286E-02
69   .345E 02   .138E 00   .286E-02
70   .350E 02   .138E 00   .286E-02
71   .355E 02   .137E 00   .286E-02
72   .360E 02   .137E 00   .286E-02
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 73   .365E 02   .136E 00   .286E-02
 74   .370E 02   .135E 00   .286E-02
 75   .375E 02   .135E 00   .286E-02
 76   .380E 02   .134E 00   .286E-02
 77   .385E 02   .134E 00   .286E-02
 78   .390E 02   .133E 00   .286E-02
 79   .395E 02   .132E 00   .286E-02
 80   .400E 02   .132E 00   .286E-02
 81   .405E 02   .131E 00   .286E-02
 82   .410E 02   .131E 00   .286E-02
 83   .415E 02   .130E 00   .286E-02
 84   .420E 02   .130E 00   .286E-02
 85   .425E 02   .129E 00   .286E-02
 86   .430E 02   .129E 00   .286E-02
 87   .435E 02   .128E 00   .286E-02
 88   .440E 02   .127E 00   .286E-02
 89   .445E 02   .127E 00   .286E-02
 90   .450E 02   .126E 00   .286E-02
 91   .455E 02   .126E 00   .286E-02
 92   .460E 02   .125E 00   .286E-02
 93   .465E 02   .125E 00   .286E-02
 94   .470E 02   .124E 00   .286E-02
 95   .475E 02   .124E 00   .286E-02
 96   .480E 02   .123E 00   .286E-02
 97   .485E 02   .123E 00   .286E-02
 98   .490E 02   .123E 00   .286E-02
 99   .495E 02   .122E 00   .286E-02
100   .500E 02   .122E 00   .286E-02
101   .505E 02   .121E 00   .286E-02
102   .510E 02   .121E 00   .286E-02
103   .515E 02   .120E 00   .286E-02
104   .520E 02   .120E 00   .286E-02
105   .525E 02   .119E 00   .286E-02
106   .530E 02   .119E 00   .286E-02
107   .535E 02   .118E 00   .286E-02
108   .540E 02   .118E 00   .286E-02
109   .545E 02   .118E 00   .286E-02
110   .550E 02   .117E 00   .286E-02
111   .555E 02   .117E 00   .286E-02
112   .560E 02   .116E 00   .286E-02
113   .565E 02   .116E 00   .286E-02
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114   .570E 02   .116E 00   .286E-02
115   .575E 02   .115E 00   .286E-02
116   .580E 02   .115E 00   .286E-02
117   .585E 02   .115E 00   .286E-02
118   .590E 02   .114E 00   .286E-02
119   .595E 02   .114E 00   .286E-02
120   .600E 02   .113E 00   .286E-02
121   .605E 02   .672E-01   .243E-02
122   .610E 02   .513E-01   .173E-02
123   .615E 02   .499E-01   .129E-02
124   .620E 02   .372E-01   .100E-02
125   .625E 02   .391E-01   .802E-03
126   .630E 02   .297E-01   .657E-03
127   .635E 02   .308E-01   .548E-03
128   .640E 02   .249E-01   .466E-03
129   .645E 02   .247E-01   .402E-03
130   .650E 02   .211E-01   .350E-03
131   .655E 02   .205E-01   .309E-03
132   .660E 02   .180E-01   .275E-03
133   .665E 02   .174E-01   .246E-03
134   .670E 02   .155E-01   .222E-03
135   .675E 02   .150E-01   .202E-03
136   .680E 02   .135E-01   .184E-03
137   .685E 02   .131E-01   .169E-03
138   .690E 02   .119E-01   .156E-03
139   .695E 02   .116E-01   .144E-03
140   .700E 02   .105E-01   .134E-03
141   .705E 02   .103E-01   .125E-03
142   .710E 02   .942E-02   .117E-03
143   .715E 02   .923E-02   .110E-03
144   .720E 02   .848E-02   .103E-03
145   .725E 02   .833E-02   .970E-04
146   .730E 02   .767E-02   .916E-04
147   .735E 02   .755E-02   .867E-04
148   .740E 02   .698E-02   .822E-04
149   .745E 02   .688E-02   .781E-04
150   .750E 02   .638E-02   .743E-04
151   .755E 02   .630E-02   .708E-04
152   .760E 02   .586E-02   .676E-04
153   .765E 02   .579E-02   .646E-04
154   .770E 02   .540E-02   .618E-04
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        155   .775E 02   .534E-02   .592E-04
        156   .780E 02   .499E-02   .568E-04
        157   .785E 02   .493E-02   .545E-04
        158   .790E 02   .462E-02   .524E-04
        159   .795E 02   .457E-02   .505E-04
        160   .800E 02   .428E-02   .486E-04
        161   .805E 02   .424E-02   .468E-04
        162   .810E 02   .399E-02   .452E-04
        163   .815E 02   .395E-02   .437E-04
        164   .820E 02   .373E-02   .422E-04
        165   .825E 02   .369E-02   .408E-04
        166   .830E 02   .349E-02   .395E-04
        167   .835E 02   .346E-02   .382E-04
        168   .840E 02   .328E-02   .371E-04
        169   .845E 02   .325E-02   .359E-04
        170   .850E 02   .309E-02   .349E-04
        171   .855E 02   .306E-02   .339E-04
        172   .860E 02   .291E-02   .329E-04
        173   .865E 02   .289E-02   .320E-04
        174   .870E 02   .276E-02   .311E-04
        175   .875E 02   .273E-02   .303E-04
        176   .880E 02   .261E-02   .294E-04
        177   .885E 02   .259E-02   .287E-04
        178   .890E 02   .248E-02   .279E-04
        179   .895E 02   .246E-02   .272E-04
        180   .900E 02   .235E-02   .266E-04

      DRAWING HYDROGRAPHS FOR SEGMENT-# 1

 GRAPH TITLED
          HYDROGRAPH FOR RUNOFF FROM SEGMENT# 1 (OERLD#01)
          SURFACE RUNOFF (IN CFS.) .VS. TIME (IN MINUTES)
 HAS BEEN PLOTTED
 GRAPH TITLED
          INSTANTANEOUS SEDIMENT YEILD - SEG# 1 (OERLD#01)
          SEDIMENT YEILD (IN LBS.) .VS. TIME (IN MINUTES)
 HAS BEEN PLOTTED
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NAME = STUDY:2

   1 - JOHN GILLEY'S DATA   SANDY CLAY LOAM SITE  4.6% SLOPE  CULTIVATED BARE SPOIL
   2 -         1          0         0       10          1       50        11
   3 - 0.01      0.50       1.050E-05          0         0         0
   4 -         1          0         0         0         0         0        1
   5 -   OERLD#01 72.6    0.046   0.987   0.050   0.00    0.00    0.11    0.11
   6 -  1.00      3.00      0.50      0.00      0.00
   7 -  50.00     0.024
   8 -  1.00      0.00      400.00    400.00
   9 - 0.00154 0.00245 0.00397 0.00598 0.0079  0.0415  0.112   0.29    1.21    3.38
  10 - 8.73
  11 - 0.425   0.05    0.115   0.04    0.06    0.18    0.04    0.045   0.035   0.005
  12 - 0.005
  13 -  0.0001    2.00      0.056     1.50      0.047
  14 -  0.00957   0.00
  15 -    PURDUE1       120       180
  16 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  17 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5'    2.5
  18 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  19 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  20 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  21 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  22 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  23 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  24 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  25 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  26 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  27 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
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GENERAL WATERSHED MODELING CONDITIONS
JOHN GILLEY'S DATA   SANDY CLAY LOAM SITE  4.6% SLOPE  CULTIVATED BARE SPOIL
      NOV     NDITCH    NCULVT      NDX      NSTOM      IMAX      MM
       1        0         0         10         1         50       11


  CONVERGENCE CRITERION =      .010                    ( EPS )
  TIME INCREMENT =       .500  MINUTES                 ( DT  )
  KINEMATIC VISCOSITY =  .105E-04  SQ.FT / SEC         ( SNU )
  PARTICLE DISTRIBUTIONS DISPLAYED EVERY 20 TIME-STEPS


COMPUTATION SEQUENCE AND RESPONSE UNITS
      ISEG      IUP.1     IUP.2     IUP.3     ILAT.1    ILAT.2     ITYP
        1         0         0         0         0         0         1

BASIN CHARACTERISTICS AND GEOMETRY
 NSEG       IDSEG      SLEN      SLOP1      PERM      ALPHA       GC        CN        PMC       AMC
    1     DERLD#01    72.600      .046      .987       .050      .000      .000      .110      .110

  SIDE SLOPE OF DITCH =      1.000  FT.  H:V           ( Z     )
  DIAMETER OF CULVERT =      3.000  FT.                ( DIA   )
  MAXIMUM DEPTH OF DITCH =      .500  FT.              ( DEMAX )
  VOL OF INTER BY GROUND COVER =      .000  CU.IN      ( GCI   )
  VOL OF INTER BY CANOPY COVER =      .000  CU.IN      ( CNI   )


FLOW RESISTANCE PARAMETERS
      FKL          COEFN
   50.00000       .02400


CHANNEL CHARATERTSTICS AND FLOW RESISTANCE
 NSEG      A1          B1          OFL         OFH
    1    1.00000     .00000   400.00000   400.00000
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CHARACTERISTICS OF AVAILABLE SEDIMENT
  PARTICLE SIZE CLASSES (MM.) IN SEGMENT-#  1 -- OERLD#01      ( DNB(I,J) )
  .00154  .00245  .00397  .00598  .00790  .04150  .11200  .29000 1.21000 3.38000 8.73000
  CUMMULATIVE DISTRIBUTION IN SEGMENT-#  1 -- OERLD#01         ( PBO(I,J) )
  .42500  .05000  .11500  .04000  .06000  .18000  .04000  .04500  .03500  .00500  .00500

SEDIMENT ROUTING PARAMETERS
      AIM         BTM         AGB         BEX         DELTS
      .00010     2.00000      .05600     1.50000      .04700

RUNOFF DETACHMENT COEFFICIENTS
  ADF.1   ADF.
  .00957

RAINFALL SIMULATION
  STORM ID. :  PURDUE1                 ( ISTORM )
  RAINFALL DURATION = 120  INCR.       ( ITMAX  )
  RUNOFF DURATION = 180  INCR.         ( ITCOM  )


RAINFALL INTENSITY  PER TIME INCREMENT
     TE:    54.321  IN./HR.         ( DR(I,J) )
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
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RUNOFF SIMULATION  BY SEGMENT
  TIME INCREMENT =       .500  MINUTES      ( DT    )
  RUNOFF DURATION = 180  INCR.              ( ITCOM )
  RAINFALL DURATION = 120  INCR.            ( ITMAX )

RAINFALL SIMULATION
  STORM ID. :  PURDUE1                   ( ISTORM )
  RAINFALL DURATION = 120  INCR.         ( ITMAX )
  RUNOFF DURATION = 180  INCR.           ( ITCOM )


CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS     ( PB1(I,J) )
     TIME-STEP =   20
  SEGMENT-#  1  --  OERLD#01
  .00756  .00089  .00204  .00071  .00107  .48464  .11301  .19504  .15170  .02167  .02167

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS     ( PB1(I,J) )
     TIME-STEP =   40
  SEGMENT-#  1  --  OERLD#01
  .00750  .00088  .00203  .00071  .00106  .29586  .11182  .29007  .22561  .03223  .03223

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS     ( PB1(I,J) )
     TIME-STEP =   60
  SEGMENT-#  1  --  OERLD#01
  .00844  .00099  .00228  .00079  .00119  .17869  .07672  .36544  .28423  .04061  .04061

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS     ( PB1(I,J) )
     TIME-STEP =   80
  SEGMENT-#  1  --  OERLD#01
  .00863  .00102  .00234  .00081  .00122  .11714  .05911  .40487  .31490  .04499  .04499

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS     ( PB1(I,J) )
     TIME-STEP =  100
  SEGMENT-#  1  --  OERLD#01
  .00840  .00099  .00227  .00079  .00119  .09252  .04820  .42282  .32886  .04698  .04698

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS     ( PB1(I,J) )
     TIME-STEP =  120
  SEGMENT-#  1  --  OERLD#01
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 .00805  .00095  .00218  .00076  .00114  .08185  .04158  .43175  .33580  .04797  .04797

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS     ( PB1(I,J) )
     TIME-STEP =  140
  SEGMENT-#  1  --  OERLD#01
 .17039  .02005  .04610  .01604  .02405  .05642  .04819  .30938  .24063  .03438  .03438

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS     ( PB1(I,J) )
     TIME-STEP =  160
  SEGMENT-#  1  --  OERLD#01
 .16509  .01942  .04467  .01554  .02331  .07602  .05097  .30249  .23527  .03361  .03361

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS     ( PB1(I,J) )
     TIME-STEP =  180
  SEGMENT-#  1  --  OERLD#01
 .15122  .01779  .04092  .01423  .02135  .08672  .05285  .30746  .23913  .03416  .03416
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OUTFLOW FROM SEGMENT-#  1 -- OERLD#01

      TIME         WATER      SEDIMENT
     STEP-#       IN CFS.     IN LBS.
        1        .164E-05   .221E-04
        2        .147E-04   .251E-03
        3        .573E-04   .125E-02
        4        .152E-03   .411E-02
        5        .317E-03   .108E-01
        6        .564E-03   .243E-01
        7        .884E-03   .468E-01
        8        .124E-02   .781E-01
        9        .159E-02   .113E 00
       10        .188E-02   .147E 00
       11        .210E-02   .168E 00
       12        .226E-02   .178E 00
       13        .236E-02   .179E 00
       14        .243E-02   .165E 00
       15        .247E-02   .157E 00
       16        .250E-02   .152E 00
       17        .251E-02   .148E 00
       18        .252E-02   .145E 00
       19        .253E-02   .141E 00
       20        .254E-02   .137E 00
       21        .254E-02   .133E 00
       22        .254E-02   .129E 00
       23        .254E-02   .125E 00
       24        .254E-02   .122E 00
       25        .254E-02   .117E 00
       26        .254E-02   .114E 00
       27        .254E-02   .109E 00
       28        .254E-02   .106E 00
       29        .254E-02   .101E 00
       30        .254E-02   .979E-01
       31        .254E-02   .934E-01
       32        .254E-02   .901E-01
       33        .254E-02   .865E-01
       34        .254E-02   .839E-01
       35        .254E-02   .808E-01
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36          .254E-02   .785E-01
37          .254E-02   .757E-01
38          .254E-02   .737E-01
39          .254E-02   .710E-01
40          .254E-02   .690E-01
41          .254E-02   .663E-01
42          .254E-02   .644E-01
43          .254E-02   .618E-01
44          .254E-02   .594E-01
45          .254E-02   .576E-01
46          .254E-02   .559E-01
47          .254E-02   .545E-01
48          .254E-02   .530E-01
49          .254E-02   .518E-01
50          .254E-02   .505E-01
51          .254E-02   .494E-01
52          .254E-02   .483E-01
53          .254E-02   .472E-01
54          .254E-02   .461E-01
55          .254E-02   .451E-01
56          .254E-02   .439E-01
57          .254E-02   .430E-01
58          .254E-02   .419E-01
59          .254E-02   .411E-01
60          .254E-02   .401E-01
61          .254E-02   .394E-01
62          .254E-02   .385E-01
63          .254E-02   .378E-01
64          .254E-02   .369E-01
65          .254E-02   .363E-01
66          .254E-02   .355E-01
67          .254E-02   .348E-01
68          .254E-02   .340E-01
69          .254E-02   .333E-01
70          .254E-02   .325E-01
71          .254E-02   .320E-01
72          .254E-02   .313E-01
73          .254E-02   .309E-01
74          .254E-02   .302E-01
75          .254E-02   .299E-01
76          .254E-02   .294E-01
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 77         .254E-02  .291E-01
 78         .254E-02  .288E-01
 79         .254E-02  .284E-01
 80         .254E-02  .280E-01
 81         .254E-02  .277E-01
 82         .254E-02  .274E-01
 83         .254E-02  .272E-01
 84         .254E-02  .269E-01
 85         .254E-02  .267E-01
 86         .254E-02  .264E-01
 87         .254E-02  .262E-01
 88         .254E-02  .260E-01
 89         .254E-02  .259E-01
 90         .254E-02  .256E-01
 91         .254E-02  .255E-01
 92         .254E-02  .253E-01
 93         .254E-02  .252E-01
 94         .254E-02  .251E-01
 95         .254E-02  .250E-01
 96         .254E-02  .248E-01
 97         .254E-02  .247E-01
 98         .254E-02  .246E-01
 99         .254E-02  .245E-01
100         .254E-02  .244E-01
101         .254E-02  .243E-01
102         .254E-02  .242E-01
103         .254E-02  .242E-01
104         .254E-02  .241E-01
105         .254E-02  .240E-01
106         .254E-02  .239E-01
107         .254E-02  .238E-01
108         .254E-02  .238E-01
109         .254E-02  .237E-01
110         .254E-02  .236E-01
111         .254E-02  .236E-01
112         .254E-02  .235E-01
113         .254E-02  .234E-01
114         .254E-02  .234E-01
115         .254E-02  .233E-01
116         .254E-02  .233E-01
117         .254E-02  .232E-01
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118          .254E-02  .231E-01
119          .254E-02  .231E-01
120          .254E-02  .230E-01
121          .224E-02  .138E-01
122          .173E-02  .125E-01
123          .138E-02  .123E-01
124          .112E-02  .107E-01
125          .929E-03  .109E-01
126          .784E-03  .908E-02
127          .671E-03  .953E-02
128          .582E-03  .804E-02
129          .510E-03  .822E-02
130          .451E-03  .722E-02
131          .402E-03  .716E-02
132          .361E-03  .648E-02
133          .327E-03  .635E-02
134          .297E-03  .583E-02
135          .272E-03  .570E-02
136          .250E-03  .527E-02
137          .230E-03  .516E-02
138          .213E-03  .479E-02
139          .198E-03  .470E-02
140          .185E-03  .437E-02
141          .173E-03  .430E-02
142          .162E-03  .401E-02
143          .152E-03  .396E-02
144          .144E-03  .370E-02
145          .136E-03  .365E-02
146          .128E-03  .342E-02
147          .122E-03  .338E-02
148          .116E-03  .318E-02
149          .110E-03  .314E-02
150          .105E-03  .296E-02
151          .100E-03  .293E-02
152          .956E-04  .276E-02
153          .915E-04  .274E-02
154          .877E-04  .258E-02
155          .841E-04  .256E-02
156          .807E-04  .242E-02
157          .776E-04  .240E-02
158          .747E-04  .228E-02
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       159         .719E-04   .226E-02
       160         .694E-04   .214E-02
       161         .669E-04   .213E-02
       162         .646E-04   .202E-02
       163         .625E-04   .200E-02
       164         .604E-04   .190E-02
       165         .585E-04   .189E-02
       166         .566E-04   .180E-02
       167         .549E-04   .179E-02
       168         .532E-04   .170E-02
       169         .516E-04   .169E-02
       170         .501E-04   .161E-02
       171         .487E-04   .160E-02
       172         .474E-04   .153E-02
       173         .461E-04   .152E-02
       174         .448E-04   .145E-02
       175         .436E-04   .144E-02
       176         .425E-04   .138E-02
       177         .414E-04   .137E-02
       178         .404E-04   .131E-02
       179         .394E-04   .130E-02
       180         .384E-04   .124E-02

TOTAL YIELD:     WATER      SEDIMENT
                IN CFS.      IN LBS.
                 .905E 01   .687E 01
```

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     GRAPHIC DISPLAYS FOR SIMULATED RUNOFF

HYDROGRAPH FOR RUNOFF FROM SEGMENT# 1 (OFRLD#01)
WATER AND SEDIMENT YEILDS .VS. SIMULATION TIME
       1       180       .500

     READING RUNOFF DATA
        IT    TIME       SGBU       QOUT

         1  .500E 00  .221E-04  .164E-05
         2  .100E 01  .251E-03  .147E-04
         3  .150E 01  .125E-02  .573E-04
         4  .200E 01  .411E-02  .152E-03
         5  .250E 01  .108E-01  .317E-03
         6  .300E 01  .243E-01  .564E-03
         7  .350E 01  .468E-01  .884E-03
         8  .400E 01  .781E-01  .124E-02
         9  .450E 01  .113E 00  .159E-02
        10  .500E 01  .147E 00  .188E-02
        11  .550E 01  .168E 00  .210E-02
        12  .600E 01  .178E 00  .226E-02
        13  .650E 01  .179E 00  .236E-02
        14  .700E 01  .165E 00  .243E-02
        15  .750E 01  .157E 00  .247E-02
        16  .800E 01  .152E 00  .250E-02
        17  .850E 01  .148E 00  .251E-02
        18  .900E 01  .145E 00  .252E-02
        19  .950E 01  .141E 00  .253E-02
        20  .100E 02  .137E 00  .254E-02
        21  .105E 02  .133E 00  .254E-02
        22  .110E 02  .129E 00  .254E-02
        23  .115E 02  .125E 00  .254E-02
        24  .120E 02  .122E 00  .254E-02
        25  .125E 02  .117E 00  .254E-02
        26  .130E 02  .114E 00  .254E-02
        27  .135E 02  .109E 00  .254E-02
        28  .140E 02  .106E 00  .254E-02
        29  .145E 02  .101E 00  .254E-02
        30  .150E 02  .979E-01  .254E-02
        31  .155E 02  .934E-01  .254E-02
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32  .160E 02  .901E-01  .254E-02
33  .165E 02  .865E-01  .254E-02
34  .170E 02  .839E-01  .254E-02
35  .175E 02  .808E-01  .254E-02
36  .180E 02  .785E-01  .254E-02
37  .185E 02  .757E-01  .254E-02
38  .190E 02  .737E-01  .254E-02
39  .195E 02  .710E-01  .254E-02
40  .200E 02  .690E-01  .254E-02
41  .205E 02  .663E-01  .254E-02
42  .210E 02  .644E-01  .254E-02
43  .215E 02  .618E-01  .254E-02
44  .220E 02  .594E-01  .254E-02
45  .225E 02  .576E-01  .254E-02
46  .230E 02  .559E-01  .254E-02
47  .235E 02  .545E-01  .254E-02
48  .240E 02  .530E-01  .254E-02
49  .245E 02  .518E-01  .254E-02
50  .250E 02  .505E-01  .254E-02
51  .255E 02  .494E-01  .254E-02
52  .260E 02  .483E-01  .254E-02
53  .265E 02  .472E-01  .254E-02
54  .270E 02  .461E-01  .254E-02
55  .275E 02  .451E-01  .254E-02
56  .280E 02  .439E-01  .254E-02
57  .285E 02  .430E-01  .254E-02
58  .290E 02  .419E-01  .254E-02
59  .295E 02  .411E-01  .254E-02
60  .300E 02  .401E-01  .254E-02
61  .305E 02  .394E-01  .254E-02
62  .310E 02  .385E-01  .254E-02
63  .315E 02  .378E-01  .254E-02
64  .320E 02  .369E-01  .254E-02
65  .325E 02  .363E-01  .254E-02
66  .330E 02  .355E-01  .254E-02
67  .335E 02  .348E-01  .254E-02
68  .340E 02  .340E-01  .254E-02
69  .345E 02  .333E-01  .254E-02
70  .350E 02  .325E-01  .254E-02
71  .355E 02  .320E-01  .254E-02
72  .360E 02  .313E-01  .254E-02
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 73   .365E 02   .309E-01   .254E-02
 74   .370E 02   .302E-01   .254E-02
 75   .375E 02   .299E-01   .254E-02
 76   .380E 02   .294E-01   .254E-02
 77   .385E 02   .291E-01   .254E-02
 78   .390E 02   .286E-01   .254E-02
 79   .395E 02   .284E-01   .254E-02
 80   .400E 02   .280E-01   .254E-02
 81   .405E 02   .277E-01   .254E-02
 82   .410E 02   .274E-01   .254E-02
 83   .415E 02   .272E-01   .254E-02
 84   .420E 02   .269E-01   .254E-02
 85   .425E 02   .267E-01   .254E-02
 86   .430E 02   .264E-01   .254E-02
 87   .435E 02   .262E-01   .254E-02
 88   .440E 02   .260E-01   .254E-02
 89   .445E 02   .259E-01   .254E-02
 90   .450E 02   .256E-01   .254E-02
 91   .455E 02   .255E-01   .254E-02
 92   .460E 02   .253E-01   .254E-02
 93   .465E 02   .252E-01   .254E-02
 94   .470E 02   .251E-01   .254E-02
 95   .475E 02   .250E-01   .254E-02
 96   .480E 02   .248E-01   .254E-02
 97   .485E 02   .247E-01   .254E-02
 98   .490E 02   .246E-01   .254E-02
 99   .495E 02   .245E-01   .254E-02
100   .500E 02   .244E-01   .254E-02
101   .505E 02   .243E-01   .254E-02
102   .510E 02   .242E-01   .254E-02
103   .515E 02   .242E-01   .254E-02
104   .520E 02   .241E-01   .254E-02
105   .525E 02   .240E-01   .254E-02
106   .530E 02   .239E-01   .254E-02
107   .535E 02   .238E-01   .254E-02
108   .540E 02   .238E-01   .254E-02
109   .545E 02   .237E-01   .254E-02
110   .550E 02   .236E-01   .254E-02
111   .555E 02   .236E-01   .254E-02
112   .560E 02   .235E-01   .254E-02
113   .565E 02   .234E-01   .254E-02
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114   .570E 02   .234E-01   .254E-02
115   .575E 02   .233E-01   .254E-02
116   .580E 02   .233E-01   .254E-02
117   .585E 02   .232E-01   .254E-02
118   .590E 02   .231E-01   .254E-02
119   .595E 02   .231E-01   .254E-02
120   .600E 02   .230E-01   .254E-02
121   .605E 02   .138E-01   .224E-02
122   .610E 02   .125E-01   .173E-02
123   .615E 02   .123E-01   .138E-02
124   .620E 02   .107E-01   .112E-02
125   .625E 02   .109E-01   .929E-03
126   .630E 02   .908E-02   .784E-03
127   .635E 02   .953E-02   .671E-03
128   .640E 02   .804E-02   .582E-03
129   .645E 02   .822E-02   .510E-03
130   .650E 02   .722E-02   .451E-03
131   .655E 02   .716E-02   .402E-03
132   .660E 02   .648E-02   .361E-03
133   .665E 02   .635E-02   .327E-03
134   .670E 02   .583E-02   .297E-03
135   .675E 02   .570E-02   .272E-03
136   .680E 02   .527E-02   .250E-03
137   .685E 02   .516E-02   .230E-03
138   .690E 02   .479E-02   .213E-03
139   .695E 02   .470E-02   .198E-03
140   .700E 02   .437E-02   .185E-03
141   .705E 02   .430E-02   .173E-03
142   .710E 02   .401E-02   .162E-03
143   .715E 02   .396E-02   .152E-03
144   .720E 02   .370E-02   .144E-03
145   .725E 02   .365E-02   .136E-03
146   .730E 02   .342E-02   .128E-03
147   .735E 02   .338E-02   .122E-03
148   .740E 02   .318E-02   .116E-03
149   .745E 02   .314E-02   .110E-03
150   .750E 02   .296E-02   .105E-03
151   .755E 02   .293E-02   .100E-03
152   .760E 02   .276E-02   .956E-04
153   .765E 02   .274E-02   .915E-04
154   .770E 02   .258E-02   .877E-04
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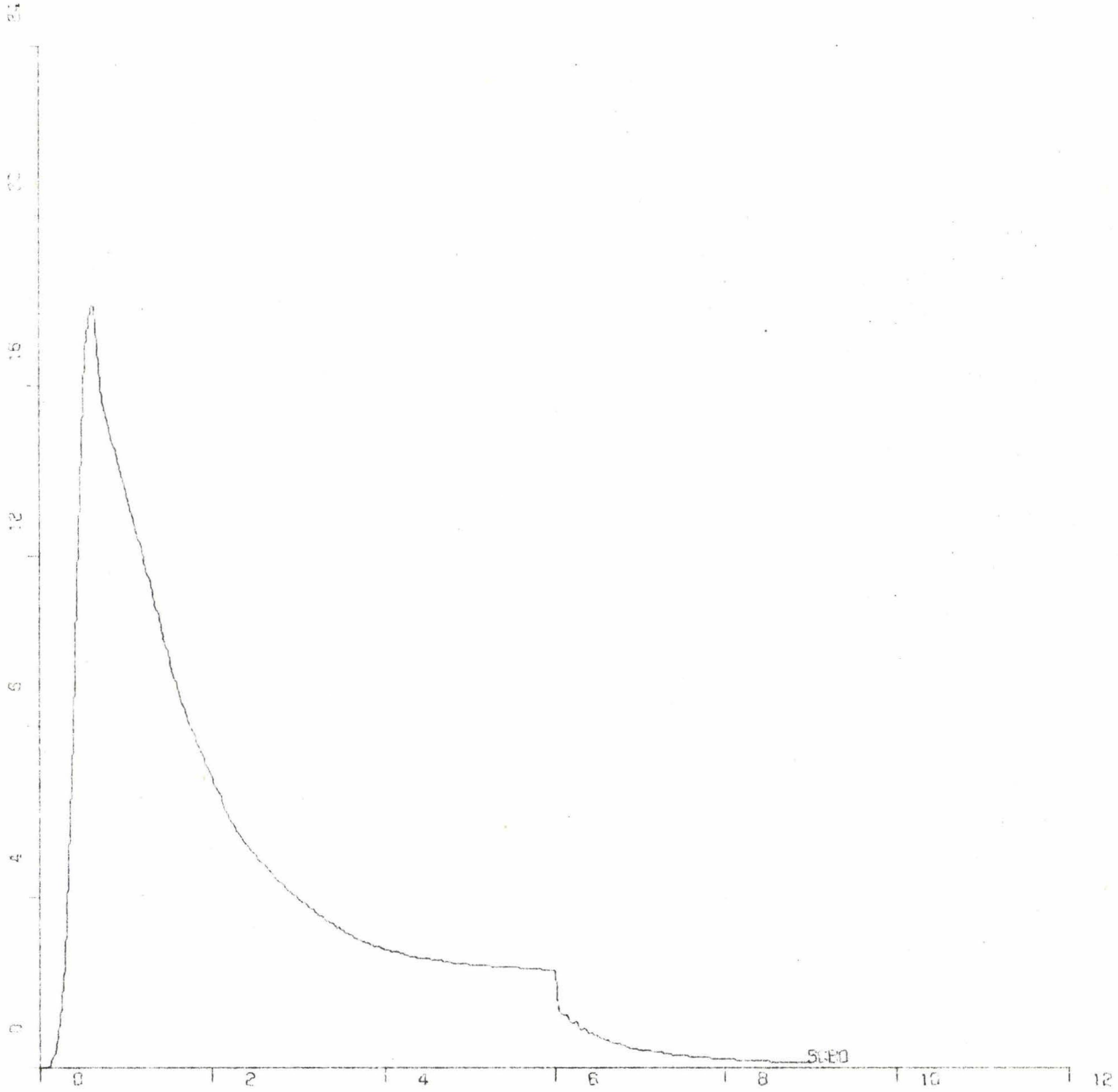
       155  .775E 02  .256E-02  .841E-04
       156  .780E 02  .242E-02  .807E-04
       157  .785E 02  .240E-02  .776E-04
       158  .790E 02  .228E-02  .747E-04
       159  .795E 02  .226E-02  .719E-04
       160  .800E 02  .214E-02  .694E-04
       161  .805E 02  .213E-02  .669E-04
       162  .810E 02  .202E-02  .646E-04
       163  .815E 02  .200E-02  .625E-04
       164  .820E 02  .190E-02  .604E-04
       165  .825E 02  .189E-02  .585E-04
       166  .830E 02  .180E-02  .566E-04
       167  .835E 02  .179E-02  .549E-04
       168  .840E 02  .170E-02  .532E-04
       169  .845E 02  .169E-02  .516E-04
       170  .850E 02  .161E-02  .501E-04
       171  .855E 02  .160E-02  .487E-04
       172  .860E 02  .153E-02  .474E-04
       173  .865E 02  .152E-02  .461E-04
       174  .870E 02  .145E-02  .448E-04
       175  .875E 02  .144E-02  .436E-04
       176  .880E 02  .138E-02  .425E-04
       177  .885E 02  .137E-02  .414E-04
       178  .890E 02  .131E-02  .404E-04
       179  .895E 02  .130E-02  .394E-04
       180  .900E 02  .124E-02  .384E-04

     DRAWING HYDROGRAPHS FOR SEGMENT-# 1

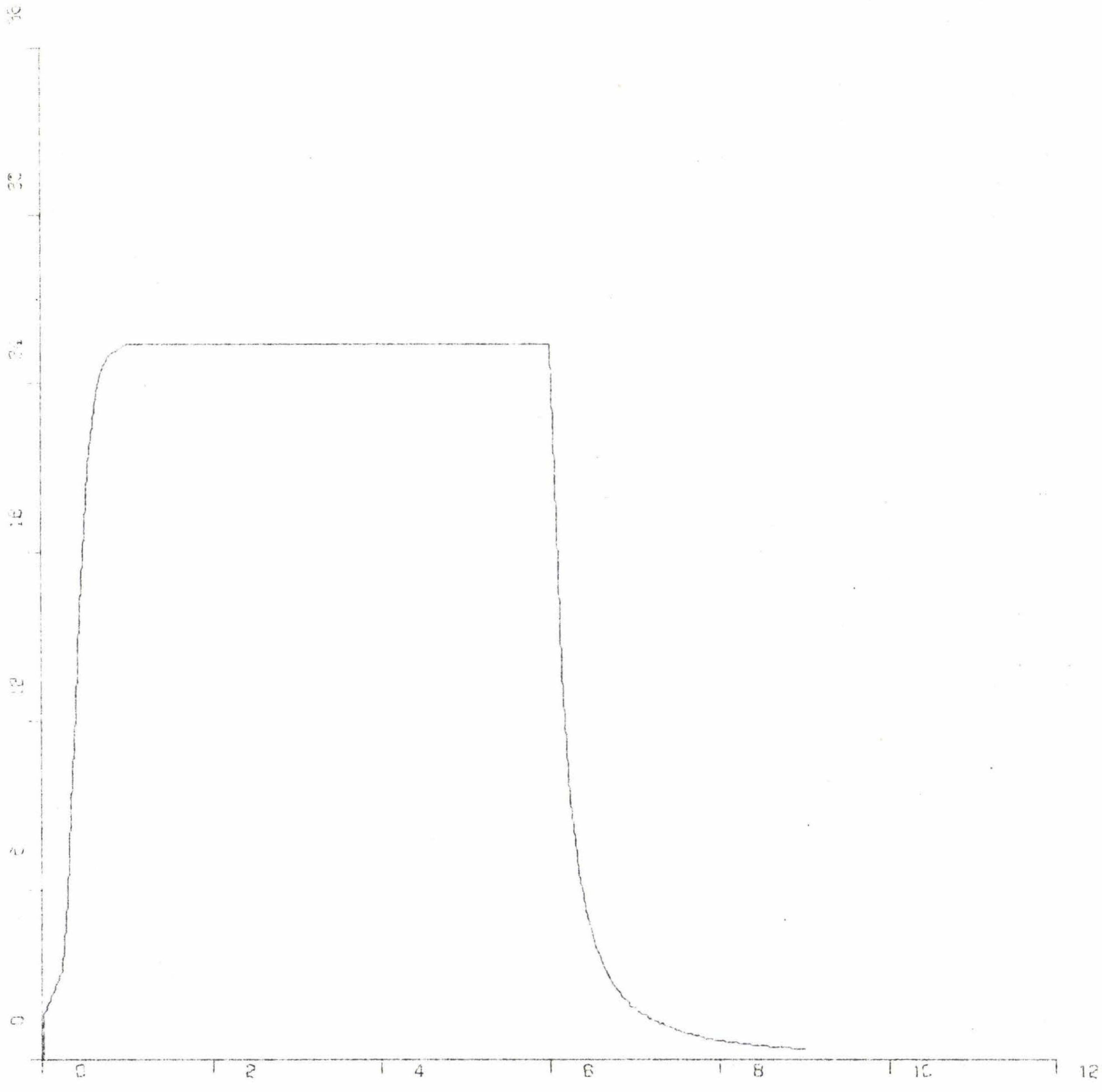
 GRAPH TITLED
          HYDROGRAPH FOR RUNOFF FROM SEGMENT# 1 (OERLD#01)
          SEDIMENT YEILD (IN LBS.) .VS. TIME (IN MINUTES)
 HAS BEEN PLOTTED
 GRAPH TITLED
          HYDROGRAPH FOR RUNOFF FROM SEGMENT# 1 (OERLD#01)
          WATER RUNOFF (IN CFS.) .VS. TIME (IN MINUTES)
 HAS BEEN PLOTTED
EOD
EOD
```



X SCALE=2.00E 01

Y SCALE=4.00E-02

HYDROGRAPH FOR RUNOFF FROM SEGMENT# 1 (OERLD#01)
SEDIMENT YEILD (IN LBS.) .VS. TIME (IN MINUTES)



X SCALE=2.00E 01

Y SCALE=6.00E-04

HYDROGRAPH FOR RUNOFF FROM SEGMENT# 1 (OERLD#01)
WATER RUNOFF (IN CFS.) .VS. TIME (IN MINUTES)

```
NAME = STUDY:3

   1 - JOHN GILLEY'S DATA   SANDY CLAY LOAM SITE  17% SLOPE   CULTIVATED BARE SPOIL
   2 -          1         0         0        10         1        50        11
   3 - 0.01      0.50       1.050E-05         0         0         0
   4 -          1         0         0         0         0         0         1
   5 -   OERLD#01 72.6    0.17    0.291   0.050   0.00    0.00    0.11    0.11
   6 -  1.00      3.00      0.50      0.00      0.00
   7 -  50.00     0.024
   8 -  1.00      0.00      400.00    400.00
   9 - 0.00154 0.00245 0.00397 0.00598 0.0079  0.0415  0.112   0.29    1.21    3.38
  10 - 8.73
  11 - 0.425   0.05    0.115   0.04    0.06    0.16    0.04    0.045   0.035   0.005
  12 - 0.005
  13 -  0.0001    2.00      0.056     1.50      0.047
  14 -  0.00957   0.00
  15 -   PURDUE1       120       180
  16 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  17 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  18 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  19 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  20 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  21 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  22 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  23 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  24 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  25 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  26 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
  27 -  2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5     2.5
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GENERAL WATERSHED MODELING CONDITIONS
JOHN GILLEY'S DATA   SANDY CLAY LOAM SITE  17% SLOPE   CULTIVATED BARE SPOIL
       NOV     NDITCH    NCULVT      NDX     NSTOM      IMAX        MM
         1         0         0        10         1        50        11


  CONVERGENCE CRITERION =      .010                  ( EPS )
  TIME INCREMENT =      .500  MINUTES               ( DT  )
  KINEMATIC VISCOSITY =  .105E-04  SQ.FT / SEC      ( SNU )
  PARTICLE DISTRIBUTIONS DISPLAYED EVERY 20 TIME-STEPS


COMPUTATION SEQUENCE AND RESPONSE UNITS
      ISEG     IUP.1     IUP.2     IUP.3    ILAT.1    ILAT.2      ITYP
         1         0         0         0         0         0         1

BASIN CHARACTERISTICS AND GEOMETRY
 NSEG      IDSEG       SLEN     SLOP1      PERM     ALPHA        GC        CN       PMC       AMC
    1     OERLD#01    72.600      .170      .291      .050      .000      .000      .110      .110

  SIDE SLOPE OF DITCH =     1.000  FT.  H:V         ( Z     )
  DIAMETER OF CULVERT =     3.000  FT.              ( DIA   )
  MAXIMUM DEPTH OF DITCH =       .500  FT.          ( DEMAX )
  VOL OF INTER BY GROUND COVER =      .000  CU.IN   ( GCI  )
  VOL OF INTER BY CANOPY COVER =      .000  CU.IN   ( CNI  )


FLOW RESISTANCE PARAMETERS
      FKL         COEFN
    50.00000      .02400


CHANNEL CHARATERISTICS AND FLOW RESISTANCE
 NSEG     A1          B1          OFL         OFH
    1     1.00000      .00000   400.00000   400.00000
```

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CHARACTERISTICS OF AVAILABLE SEDIMENT
  PARTICLE SIZE CLASSES (MM.) IN SEGMENT-#  1 -- OERLD#01      ( DNB(I,J) )
  .00154  .00245  .00397  .00598  .00790  .04150  .11200  .29000 1.21000 3.38000 8.73000
  CUMMULATIVE DISTRIBUTION IN SEGMENT-#  1 -- OERLD#01         ( PBO(I,J) )
  .42500  .05000  .11500  .04000  .06000  .18000  .04000  .04500  .03500  .00500  .00500

SEDIMENT ROUTING PARAMETERS
      AIM         BIM         AGB         BEX         DELTS
     .00010     2.00000      .05600     1.50000      .04700

RUNOFF DETACHMENT COEFFICIENTS
  ADF.1   ADF.
  .00957

RAINFALL SIMULATION
  STORM ID. :  PURDUE1                 ( ISTORM )
  RAINFALL DURATION = 120  INCR.       ( ITMAX  )
  RUNOFF DURATION = 180  INCR.         ( ITCOM  )


RAINFALL INTENSITY  PER TIME INCREMENT
     IE:     54.321  IN./HR.           ( DR(I,J) )
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500   2.500
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RUNOFF SIMULATION  BY SEGMENT
  TIME INCREMENT =       .500  MINUTES       ( DT     )
  RUNOFF DURATION = 180  INCR.               ( ITCOM )
  RAINFALL DURATION = 120  INCR.             ( ITMAX )

RAINFALL SIMULATION
  STORM ID. :  PURDUE1                    ( ISTORM )
  RAINFALL DURATION = 120  INCR.          ( ITMAX )
  RUNOFF DURATION = 180  INCR.            ( ITCOM )


CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS      ( PB1(I,J) )
     TIME-STEP =   20
  SEGMENT-#  1  --  OERLD#01
  .00141  .00017  .28113  .09808  .14687  .00060  .08820  .19840  .14400  .02057  .02057

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS      ( PB1(I,J) )
     TIME-STEP =   40
  SEGMENT-#  1  --  OERLD#01
  .00405  .00048  .00598  .01836  .04765  .00172  .00038  .10066  .63835  .09119  .09119

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS      ( PB1(I,J) )
     TIME-STEP =   60
  SEGMENT-#  1  --  OERLD#01
  .00462  .00054  .00125  .00043  .00065  .00196  .00043  .03394  .74370  .10624  .10624

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS      ( PB1(I,J) )
     TIME-STEP =   80
  SEGMENT-#  1  --  OERLD#01
  .00459  .00054  .00124  .00043  .00065  .00194  .00043  .02250  .75264  .10752  .10752

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS      ( PB1(I,J) )
     TIME-STEP =  100
  SEGMENT-#  1  --  OERLD#01
  .00453  .00053  .00123  .00043  .00064  .00192  .00043  .01909  .75539  .10791  .10791

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS      ( PB1(I,J) )
     TIME-STEP =  120
  SEGMENT-#  1  --  OERLD#01
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 .00446  .00053  .00121  .00042  .00063  .00189  .00042  .01761  .75666  .10809  .10809

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS      ( PB1(I,J) )
     TIME-STEP =  140
  SEGMENT-#  1  --  OERLD#01
 .09074  .01068  .02455  .00854  .01281  .00000  .01304  .02611  .63276  .09039  .09039

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS      ( PB1(I,J) )
     TIME-STEP =  160
  SEGMENT-#  1  --  OERLD#01
 .09076  .01068  .02456  .00854  .01281  .00858  .01494  .02594  .62471  .08924  .08924

CUMMULATIVE DISTRIBUTIONS OF TRANSPORTED SEDIMENTS      ( PB1(I,J) )
     TIME-STEP =  180
  SEGMENT-#  1  --  OERLD#01
 .08908  .01048  .02410  .00838  .01258  .02233  .01544  .02558  .61603  .08800  .08800
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OUTFLOW FROM SEGMENT-#  1 -- OERLD#01

        TIME          WATER      SEDIMENT
       STEP-#        IN CFS.      IN LBS.
           1        .183E-04   .511E-03
           2        .167E-03   .806E-02
           3        .639E-03   .533E-01
           4        .144E-02   .179E 00
           5        .229E-02   .369E 00
           6        .293E-02   .539E 00
           7        .332E-02   .593E 00
           8        .353E-02   .554E 00
           9        .363E-02   .469E 00
          10        .367E-02   .397E 00
          11        .369E-02   .419E 00
          12        .370E-02   .396E 00
          13        .371E-02   .482E 00
          14        .371E-02   .492E 00
          15        .371E-02   .537E 00
          16        .371E-02   .540E 00
          17        .371E-02   .552E 00
          18        .371E-02   .550E 00
          19        .371E-02   .534E 00
          20        .371E-02   .528E 00
          21        .371E-02   .503E 00
          22        .371E-02   .495E 00
          23        .371E-02   .466E 00
          24        .371E-02   .455E 00
          25        .371E-02   .406E 00
          26        .371E-02   .393E 00
          27        .371E-02   .345E 00
          28        .371E-02   .333E 00
          29        .371E-02   .296E 00
          30        .371E-02   .287E 00
          31        .371E-02   .253E 00
          32        .371E-02   .238E 00
          33        .371E-02   .209E 00
          34        .371E-02   .184E 00
          35        .371E-02   .169E 00
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36          .371E-02  .154E 00
37          .371E-02  .145E 00
38          .371E-02  .134E 00
39          .371E-02  .127E 00
40          .371E-02  .119E 00
41          .371E-02  .113E 00
42          .371E-02  .108E 00
43          .371E-02  .103E 00
44          .371E-02  .989E-01
45          .371E-02  .950E-01
46          .371E-02  .919E-01
47          .371E-02  .887E-01
48          .371E-02  .860E-01
49          .371E-02  .831E-01
50          .371E-02  .810E-01
51          .371E-02  .785E-01
52          .371E-02  .768E-01
53          .371E-02  .746E-01
54          .371E-02  .732E-01
55          .371E-02  .713E-01
56          .371E-02  .701E-01
57          .371E-02  .684E-01
58          .371E-02  .674E-01
59          .371E-02  .659E-01
60          .371E-02  .650E-01
61          .371E-02  .636E-01
62          .371E-02  .628E-01
63          .371E-02  .615E-01
64          .371E-02  .609E-01
65          .371E-02  .598E-01
66          .371E-02  .592E-01
67          .371E-02  .583E-01
68          .371E-02  .579E-01
69          .371E-02  .571E-01
70          .371E-02  .568E-01
71          .371E-02  .561E-01
72          .371E-02  .558E-01
73          .371E-02  .553E-01
74          .371E-02  .550E-01
75          .371E-02  .545E-01
76          .371E-02  .542E-01
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 77        .371E-02  .538E-01
 78        .371E-02  .535E-01
 79        .371E-02  .531E-01
 80        .371E-02  .529E-01
 81        .371E-02  .525E-01
 82        .371E-02  .522E-01
 83        .371E-02  .519E-01
 84        .371E-02  .517E-01
 85        .371E-02  .513E-01
 86        .371E-02  .511E-01
 87        .371E-02  .508E-01
 88        .371E-02  .506E-01
 89        .371E-02  .504E-01
 90        .371E-02  .502E-01
 91        .371E-02  .499E-01
 92        .371E-02  .498E-01
 93        .371E-02  .495E-01
 94        .371E-02  .494E-01
 95        .371E-02  .492E-01
 96        .371E-02  .491E-01
 97        .371E-02  .489E-01
 98        .371E-02  .487E-01
 99        .371E-02  .485E-01
100        .371E-02  .484E-01
101        .371E-02  .482E-01
102        .371E-02  .481E-01
103        .371E-02  .479E-01
104        .371E-02  .478E-01
105        .371E-02  .477E-01
106        .371E-02  .476E-01
107        .371E-02  .474E-01
108        .371E-02  .473E-01
109        .371E-02  .471E-01
110        .371E-02  .470E-01
111        .371E-02  .469E-01
112        .371E-02  .468E-01
113        .371E-02  .466E-01
114        .371E-02  .465E-01
115        .371E-02  .464E-01
116        .371E-02  .463E-01
117        .371E-02  .461E-01
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118          .371E-02   .461E-01
119          .371E-02   .459E-01
120          .371E-02   .458E-01
121          .301E-02   .264E-01
122          .194E-02   .209E-01
123          .135E-02   .188E-01
124          .992E-03   .160E-01
125          .762E-03   .144E-01
126          .606E-03   .126E-01
127          .494E-03   .116E-01
128          .412E-03   .103E-01
129          .350E-03   .972E-02
130          .301E-03   .871E-02
131          .263E-03   .832E-02
132          .232E-03   .752E-02
133          .206E-03   .724E-02
134          .185E-03   .660E-02
135          .167E-03   .639E-02
136          .152E-03   .587E-02
137          .139E-03   .569E-02
138          .127E-03   .526E-02
139          .117E-03   .512E-02
140          .109E-03   .476E-02
141          .101E-03   .464E-02
142          .942E-04   .433E-02
143          .881E-04   .423E-02
144          .827E-04   .396E-02
145          .777E-04   .388E-02
146          .733E-04   .365E-02
147          .692E-04   .357E-02
148          .655E-04   .338E-02
149          .622E-04   .332E-02
150          .591E-04   .315E-02
151          .562E-04   .309E-02
152          .536E-04   .294E-02
153          .511E-04   .289E-02
154          .489E-04   .277E-02
155          .468E-04   .271E-02
156          .449E-04   .261E-02
157          .430E-04   .254E-02
158          .413E-04   .246E-02
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       159        .397E-04  .240E-02
       160        .382E-04  .233E-02
       161        .368E-04  .227E-02
       162        .355E-04  .221E-02
       163        .343E-04  .216E-02
       164        .331E-04  .210E-02
       165        .320E-04  .205E-02
       166        .310E-04  .199E-02
       167        .300E-04  .196E-02
       168        .290E-04  .190E-02
       169        .281E-04  .187E-02
       170        .273E-04  .181E-02
       171        .265E-04  .179E-02
       172        .257E-04  .174E-02
       173        .250E-04  .172E-02
       174        .243E-04  .167E-02
       175        .236E-04  .165E-02
       176        .229E-04  .160E-02
       177        .223E-04  .159E-02
       178        .217E-04  .154E-02
       179        .212E-04  .153E-02
       180        .206E-04  .149E-02

TOTAL YIELD:      WATER     SEDIMENT
                 IN CFS.     IN LBS.
                  .133E 02  .190E 02
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     GRAPHIC DISPLAYS FOR SIMULATED RUNOFF

HYDROGRAPH FOR RUNOFF FROM SEGMENT# 1 (OERLD#01)
WATER AND SEDIMENT YEILDS .VS. SIMULATION TIME
        1        180        .500

     READING RUNOFF DATA
       IT    TIME       SG80       QOUT

        1  .500E 00  .511E-03  .183E-04
        2  .100E 01  .806E-02  .167E-03
        3  .150E 01  .533E-01  .639E-03
        4  .200E 01  .179E 00  .144E-02
        5  .250E 01  .369E 00  .229E-02
        6  .300E 01  .539E 00  .293E-02
        7  .350E 01  .593E 00  .332E-02
        8  .400E 01  .554E 00  .353E-02
        9  .450E 01  .469E 00  .363E-02
       10  .500E 01  .397E 00  .367E-02
       11  .550E 01  .419E 00  .369E-02
       12  .600E 01  .396E 00  .370E-02
       13  .650E 01  .482E 00  .371E-02
       14  .700E 01  .492E 00  .371E-02
       15  .750E 01  .537E 00  .371E-02
       16  .800E 01  .540E 00  .371E-02
       17  .850E 01  .552E 00  .371E-02
       18  .900E 01  .550E 00  .371E-02
       19  .950E 01  .534E 00  .371E-02
       20  .100E 02  .528E 00  .371E-02
       21  .105E 02  .503E 00  .371E-02
       22  .110E 02  .495E 00  .371E-02
       23  .115E 02  .466E 00  .371E-02
       24  .120E 02  .455E 00  .371E-02
       25  .125E 02  .406E 00  .371E-02
       26  .130E 02  .393E 00  .371E-02
       27  .135E 02  .345E 00  .371E-02
       28  .140E 02  .333E 00  .371E-02
       29  .145E 02  .296E 00  .371E-02
       30  .150E 02  .287E 00  .371E-02
       31  .155E 02  .253E 00  .371E-02
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32  .160E 02  .238E 00  .371E-02
33  .165E 02  .209E 00  .371E-02
34  .170E 02  .184E 00  .371E-02
35  .175E 02  .169E 00  .371E-02
36  .180E 02  .154E 00  .371E-02
37  .185E 02  .145E 00  .371E-02
38  .190E 02  .134E 00  .371E-02
39  .195E 02  .127E 00  .371E-02
40  .200E 02  .119E 00  .371E-02
41  .205E 02  .113E 00  .371E-02
42  .210E 02  .108E 00  .371E-02
43  .215E 02  .103E 00  .371E-02
44  .220E 02  .989E-01  .371E-02
45  .225E 02  .950E-01  .371E-02
46  .230E 02  .919E-01  .371E-02
47  .235E 02  .887E-01  .371E-02
48  .240E 02  .860E-01  .371E-02
49  .245E 02  .831E-01  .371E-02
50  .250E 02  .810E-01  .371E-02
51  .255E 02  .785E-01  .371E-02
52  .260E 02  .768E-01  .371E-02
53  .265E 02  .746E-01  .371E-02
54  .270E 02  .732E-01  .371E-02
55  .275E 02  .713E-01  .371E-02
56  .280E 02  .701E-01  .371E-02
57  .285E 02  .684E-01  .371E-02
58  .290E 02  .674E-01  .371E-02
59  .295E 02  .659E-01  .371E-02
60  .300E 02  .650E-01  .371E-02
61  .305E 02  .636E-01  .371E-02
62  .310E 02  .628E-01  .371E-02
63  .315E 02  .615E-01  .371E-02
64  .320E 02  .609E-01  .371E-02
65  .325E 02  .598E-01  .371E-02
66  .330E 02  .592E-01  .371E-02
67  .335E 02  .583E-01  .371E-02
68  .340E 02  .579E-01  .371E-02
69  .345E 02  .571E-01  .371E-02
70  .350E 02  .568E-01  .371E-02
71  .355E 02  .561E-01  .371E-02
72  .360E 02  .558E-01  .371E-02
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  73   .365E 02   .553E-01   .371E-02
  74   .370E 02   .550E-01   .371E-02
  75   .375E 02   .545E-01   .371E-02
  76   .380E 02   .542E-01   .371E-02
  77   .385E 02   .538E-01   .371E-02
  78   .390E 02   .535E-01   .371E-02
  79   .395E 02   .531E-01   .371E-02
  80   .400E 02   .529E-01   .371E-02
  81   .405E 02   .525E-01   .371E-02
  82   .410E 02   .522E-01   .371E-02
  83   .415E 02   .519E-01   .371E-02
  84   .420E 02   .517E-01   .371E-02
  85   .425E 02   .513E-01   .371E-02
  86   .430E 02   .511E-01   .371E-02
  87   .435E 02   .508E-01   .371E-02
  88   .440E 02   .506E-01   .371E-02
  89   .445E 02   .504E-01   .371E-02
  90   .450E 02   .502E-01   .371E-02
  91   .455E 02   .499E-01   .371E-02
  92   .460E 02   .498E-01   .371E-02
  93   .465E 02   .495E-01   .371E-02
  94   .470E 02   .494E-01   .371E-02
  95   .475E 02   .492E-01   .371E-02
  96   .480E 02   .491E-01   .371E-02
  97   .485E 02   .489E-01   .371E-02
  98   .490E 02   .487E-01   .371E-02
  99   .495E 02   .485E-01   .371E-02
 100   .500E 02   .484E-01   .371E-02
 101   .505E 02   .482E-01   .371E-02
 102   .510E 02   .481E-01   .371E-02
 103   .515E 02   .479E-01   .371E-02
 104   .520E 02   .478E-01   .371E-02
 105   .525E 02   .477E-01   .371E-02
 106   .530E 02   .476E-01   .371E-02
 107   .535E 02   .474E-01   .371E-02
 108   .540E 02   .473E-01   .371E-02
 109   .545E 02   .471E-01   .371E-02
 110   .550E 02   .470E-01   .371E-02
 111   .555E 02   .469E-01   .371E-02
 112   .560E 02   .468E-01   .371E-02
 113   .565E 02   .466E-01   .371E-02
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114   .570E 02   .465E-01   .371E-02
115   .575E 02   .464E-01   .371E-02
116   .580E 02   .463E-01   .371E-02
117   .585E 02   .461E-01   .371E-02
118   .590E 02   .461E-01   .371E-02
119   .595E 02   .459E-01   .371E-02
120   .600E 02   .458E-01   .371E-02
121   .605E 02   .264E-01   .301E-02
122   .610E 02   .209E-01   .194E-02
123   .615E 02   .188E-01   .135E-02
124   .620E 02   .160E-01   .992E-03
125   .625E 02   .144E-01   .762E-03
126   .630E 02   .126E-01   .606E-03
127   .635E 02   .116E-01   .494E-03
128   .640E 02   .103E-01   .412E-03
129   .645E 02   .972E-02   .350E-03
130   .650E 02   .871E-02   .301E-03
131   .655E 02   .832E-02   .263E-03
132   .660E 02   .752E-02   .232E-03
133   .665E 02   .724E-02   .206E-03
134   .670E 02   .660E-02   .185E-03
135   .675E 02   .639E-02   .167E-03
136   .680E 02   .587E-02   .152E-03
137   .685E 02   .569E-02   .139E-03
138   .690E 02   .526E-02   .127E-03
139   .695E 02   .512E-02   .117E-03
140   .700E 02   .476E-02   .109E-03
141   .705E 02   .464E-02   .101E-03
142   .710E 02   .433E-02   .942E-04
143   .715E 02   .423E-02   .881E-04
144   .720E 02   .396E-02   .827E-04
145   .725E 02   .388E-02   .777E-04
146   .730E 02   .365E-02   .733E-04
147   .735E 02   .357E-02   .692E-04
148   .740E 02   .338E-02   .655E-04
149   .745E 02   .332E-02   .622E-04
150   .750E 02   .315E-02   .591E-04
151   .755E 02   .309E-02   .562E-04
152   .760E 02   .294E-02   .536E-04
153   .765E 02   .289E-02   .511E-04
154   .770E 02   .277E-02   .489E-04
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        155   .775E 02   .271E-02   .468E-04
        156   .780E 02   .261E-02   .449E-04
        157   .785E 02   .254E-02   .430E-04
        158   .790E 02   .246E-02   .413E-04
        159   .795E 02   .240E-02   .397E-04
        160   .800E 02   .233E-02   .382E-04
        161   .805E 02   .227E-02   .368E-04
        162   .810E 02   .221E-02   .355E-04
        163   .815E 02   .216E-02   .343E-04
        164   .820E 02   .210E-02   .331E-04
        165   .825E 02   .205E-02   .320E-04
        166   .830E 02   .199E-02   .310E-04
        167   .835E 02   .196E-02   .300E-04
        168   .840E 02   .190E-02   .290E-04
        169   .845E 02   .187E-02   .281E-04
        170   .850E 02   .181E-02   .273E-04
        171   .855E 02   .179E-02   .265E-04
        172   .860E 02   .174E-02   .257E-04
        173   .865E 02   .172E-02   .250E-04
        174   .870E 02   .167E-02   .243E-04
        175   .875E 02   .165E-02   .236E-04
        176   .880E 02   .160E-02   .229E-04
        177   .885E 02   .159E-02   .223E-04
        178   .890E 02   .154E-02   .217E-04
        179   .895E 02   .153E-02   .212E-04
        180   .900E 02   .149E-02   .206E-04

      DRAWING HYDROGRAPHS FOR SEGMENT-# 1

  GRAPH TITLED
           HYDROGRAPH FOR RUNOFF FROM SEGMENT# 1 (OERLD#01)
           SEDIMENT YEILD (IN LBS.) .VS. TIME (IN MINUTES)
  HAS BEEN PLOTTED
  GRAPH TITLED
           HYDROGRAPH FOR RUNOFF FROM SEGMENT# 1 (OERLD#01)
           WATER RUNOFF (IN CFS.) .VS. TIME (IN MINUTES)
  HAS BEEN PLOTTED
 EOD
 EOD
```
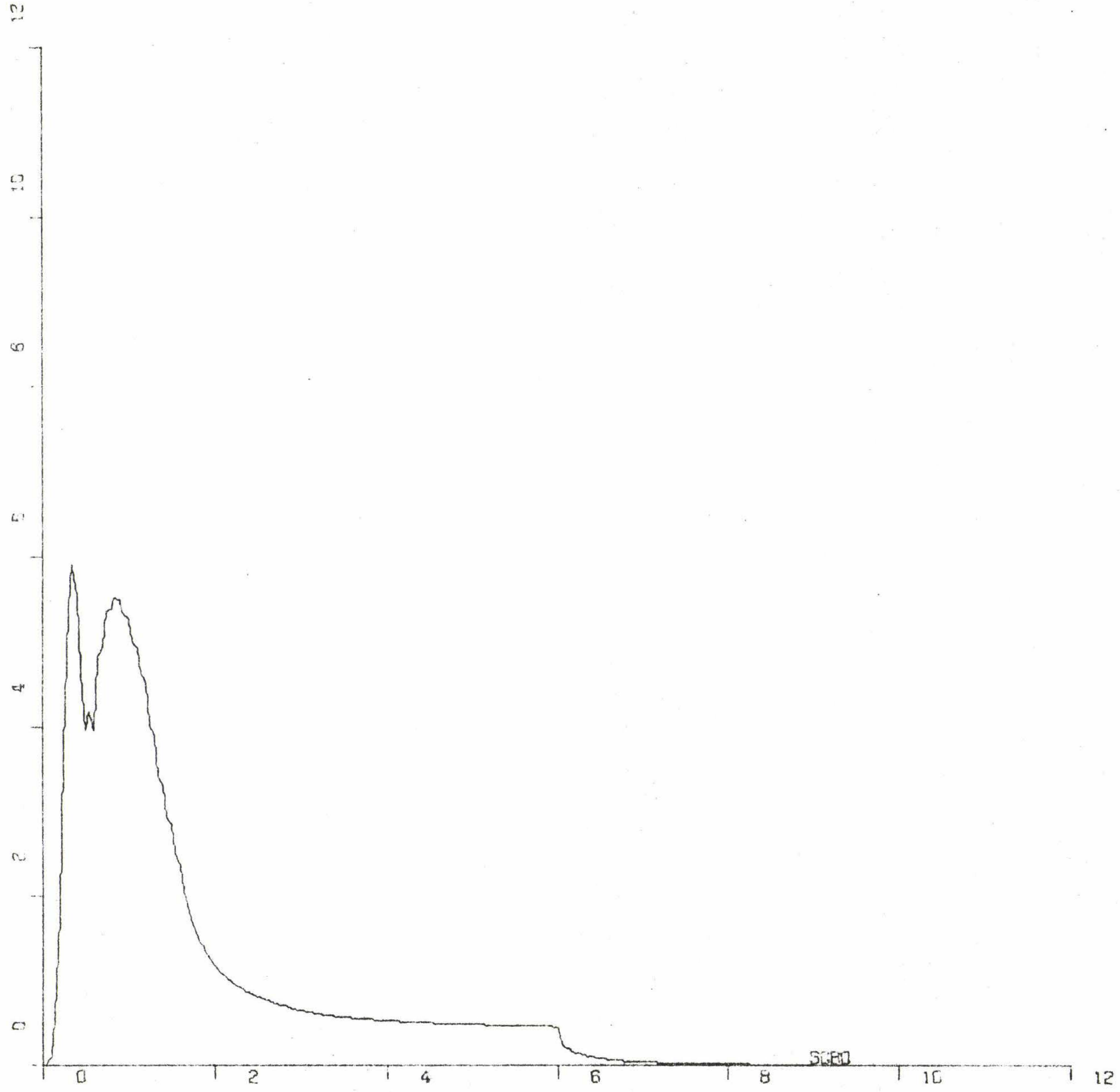
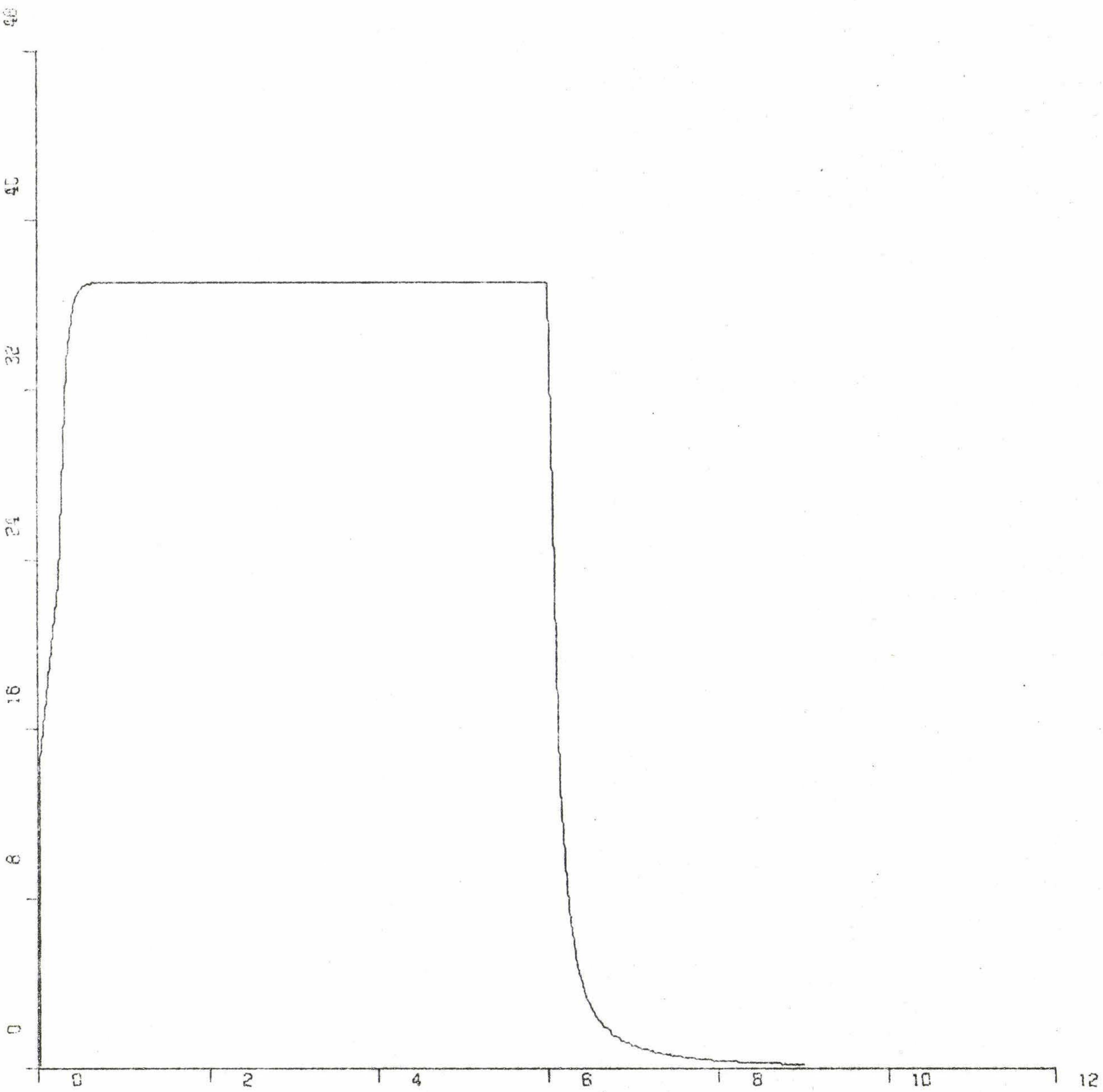



X SCALE=2.00E 01

Y SCALE=2.00E-01

HYDROGRAPH FOR RUNOFF FROM SEGMENT# 1 (OERLD#01)
SEDIMENT YEILD (IN LBS.) .VS. TIME (IN MINUTES)



X SCALE=2.00E 01

Y SCALE=8.00E-04

HYDROGRAPH FOR RUNOFF FROM SEGMENT# 1 (OERLD#01)
WATER RUNOFF (IN CFS.) .VS. TIME (IN MINUTES)